PARK SCIENCE

A RESOURCE MANAGEMENT BULLETIN

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PARK SCIENCE

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SUMMER 1982

A report to park managers of recent and on-going research in parks with emphasis on its implications for planning and management

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Cover Photo: *Volunteers at Gateway NRA (New York City) place brush in created freshwater pond to provide cover and calling sites for introduced Spring Peepers. Story page 3.*

In the Next Issue: "An Efficient Resource Mapping Alternative" by Carl H. Key; "Soil Drainage Problems in Urban Parks," by Dan Iritani; "Communication Techniques and the Scientist," by Jerry Shimoda.

From the Editor,

Three well-planned days of intensive focus on the world biosphere reserve concept – June 22-24 at Kalispell, Montana – resulted in unanimous expressions of support from the 120 participants in "Toward the Biosphere Reserve: Exploring Relationships Between Parks and Adjacent Lands."

This conference, unlike so many others, was not a one-legged stool with science as its only subject and support. Conceived by NPS Biologist Cliff Martinka and co-hosted by Glacier NP Superintendents Bob Haraden and Bernie Lieff, Waterton Lakes NP superintendent across the Canadian border, the conference was a rich, lively mix of park personnel (research and management), engineers, cattle ranchers, county commissioners, regional citizen activists, and other management agency personnel spanning local through federal and international levels.

Waterton and Glacier parks are world biosphere reserves, representing together a spectacular example of a mountain biome, their world designation coming from UNESCO's Man and the Biosphere (MAB) program. The meeting followed immediately on the heels of a gala 50th anniversary celebration of the two parks' establishment as an International Peace Park. NPS Director Russell Dickenson spoke at that ceremony on June 18.

For any who doubt the need for a network of world biosphere reserves, the three day conference in Kalispell was rich food for thought. Instead of presenting research results that could just as well have grown out of park or other research programs, conferees spent their time documenting the need for coordinated collection of information worldwide, for disseminating that information in ways that demand public attention and action, and in exploring ways to build into biosphere reserve programs the participation of surrounding areas.

Conferees concluded that the 10-year period since the idea was born had been a necessary "hatching" time. In the interim, global environmental problems have arisen to underscore the need for, and usefulness of, the "paired area" concept – the unique pairing in each reserve of a largely natural core area with an experimental area where manipulation is carried out. The fact that no overall biosphere reserve program of structured research and funding has yet emerged was viewed at Kalispell as a plus.

The rationale was that formulation of a structured program has been deferred until precisely the time when an open regional approach to such programming is becoming recognized as a way to handle a whole nest of newly-emerging needs.

"The beauty of the biosphere reserve idea," said Haraden, "is its lack of rigidity. It has attracted the participation of world science and government and at the same time has remained free to grow and adapt to the changing needs of the world. That's what we're doing here at this conference – inviting regional interests to come in and be part of the design."

They came, and they took part. Representatives of the ranching community, for instance, endorsed the goal of coordinated research worldwide, and added to the paired-area concept the idea of studying existing uses of adjoining lands. Cooperating private landholders and other public land managers would be parties to the research and would engage in the search for compatible uses. At the same time, the ranchers presented problems from the ranchers' point of view, and expressed willingness to explore with the biosphere reserve people ways in which their interests could be served within a framework of genetic preservation and ecosystem integrity.

The chairman of the Flathead River Basin Environmental Impact Study steering committee summed up the need to involve all local interests in the ongoing studies "so that the research results are internalized within the region," and the necessity of acquainting the regions around biosphere reserves with the direct tie-in between a healthy ecosystem and their own water taps, dinner tables, bank accounts, schools, clubs and churches.

Bill Gregg, NPS coordinator for MAB, called the biosphere reserve concept "a whole new dimension in world conservation," and Robert Scace of Reid, Crowther & Partners, Ltd., a Canadian firm of consulting engineers and planners, sounded the closing note – a recognition that biosphere reserve studies include man as the most important change agent in the environment:

"Let us not leave here," he said, "without recognizing that in biosphere reserves we witness the coming together of the biophysical and the human ecological ends of the biosphere spectrum."

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Representative Animal Community Being Created at Jamaica Bay

By Robert Cook

The Jamaica Bay Wildlife Refuge, a part of Gateway NRA, consists of 9,155 acres of saltwater bay, marshes, and upland habitats scattered among 25 islands in southern Brooklyn and Queens, New York City. Established in the early 1950s by the City Department of Parks, the National Park Service took over the Refuges's management in 1974 with the establishment of Gateway.

Traditionally, refuge management has focused on birds; techniques such as impoundments, water level manipulation, and food and cover plantings have been quite successful. Nearly 320 bird species have been recorded.

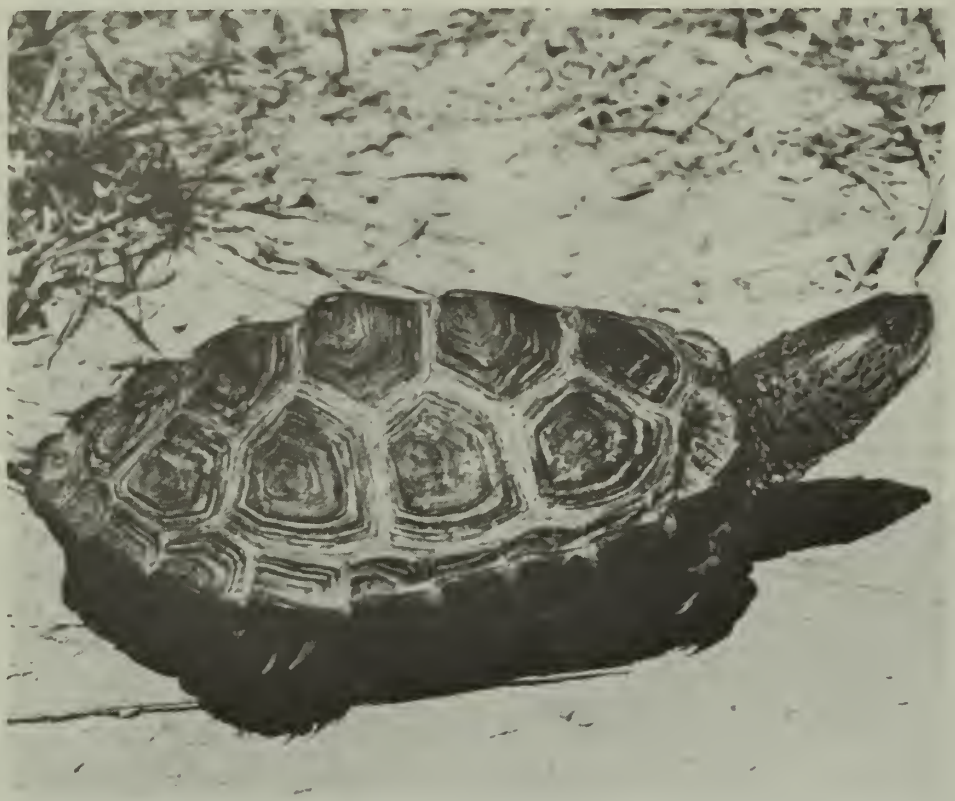
Contrasting sharply with such avian diversity is the scarcity of amphibians and reptiles (collectively known as herpetofauna) in the refuge. Of course, there are fewer species in these taxa to begin with, but other factors also have contributed to their paucity here. Their mobility is limited, so dispersal is a slow, difficult process. Originally, the islands of Jamaica Bay were all salt marsh. During this period the herpetofauna of the surrounding Brooklyn-Queens mainland were numerous and diverse. However, because of the unsuitability of salt marsh as habitat for most "herps," few species occurred in Jamaica Bay itself. In this century, dredging and landfill have created new upland and freshwater habitats on some of the Bay islands. At the same time, urbanization was eliminating most of the mainland's original herpetofauna and reducing the remaining species to remnant populations. Thus, three factors – restricted movement ability, habitat changes in and around Jamaica Bay, and the insular nature of Jamaica Bay Wildlife Refuge – have combined to produce a herpetofauna less diverse than the presently available habitats of Jamaica Bay might be expected to support.

In 1979 efforts began to inventory and determine population status of the Refuge's herpetofauna. So far, three species have been determined to occur as breeding populations. These are Fowler's Toad *(Bufo woodhousei fowleri),* Eastern Garter Snake *(Thamnophis s. sirtalis),* and the Northern Diamondback Terrapin *(Malaclemys t. terrapin).* The first two are still common along the Bay's periphery, while the terrapin is basically restricted to salt marsh and hence, has always been present. Four other species also have been relocated. The Snapping Turtle *(Chelydra serpentina)* may represent remnants of an indigenous salt-marsh dwelling population; the Eastern Painted Turtle *(Chrysemys p. picta),* the Eastern Box Turtle, and the exotic Red-eared Slider *(Chrysemys scripta elegans)* are most likely released pets.

Following inventory a two-phased plan was developed, calling for habitat improvements and introduction of regionally native species suited to the habitats originally and newly present. While intentional introductions of a non-native species into natural ecosystems generally are frowned upon by biologists and by National Park Service policy, the unique circumstances of Jamaica Bay within the New York metropolitan area justified such a course. In managing Jamaica Bay as an ecosystem where natural processes are to be preserved and restored, park managers envisioned establishing an animal community as representative of area-wide pre-urbanization conditions as desirable.

The introductions serve two purposes. First, they will create a more diverse animal community, with more complex food webs and greater ecological stability. Secondly, considering urbanization trends, the fate of many remnant populations is much in doubt. With the extirpation of these remnants, the local forms of many species would exist only as museum

An NPS technician *releases Spring Peeper tadpoles into freshwater habitat at Jamaica Bay Wildlife Refuge. The Northern Spring Peeper (above) was collected at JFK Airport to help establish a population of this species at JBWR. Photos by Robert Cook and Don Riepe.*



***Northern Diamondback Terrapin** is an estuarine turtle common in the salt marshes throughout Gateway NRA.*

specimens, and the living gene pools they represent would be gone. Here at Jamaica Bay, and throughout Gateway, we have habitats relatively devoid of animals, while throughout the Long Island area, there are remnant animal populations running out of habitat, with no chance of finding new habitats on their own.

In the spring of 1980 the program began, with habitat improvements as the first step. Such work for amphibians and reptiles is based on the same principles as applies to birds and mammals: to provide food, water, cover, and any other special life requirements. Small freshwater ponds were created by hand using high school student volunteers or, in one case, with a bulldozer. Aquatic plants and brush were added to provide food cover, perches, and egg deposition sites for amphibians.

Driftwood boards were relocated unobtrusively in meadows and woodlands as cover for snakes, toads, frogs, and their prey. Piles of leaves (disposed of each fall by urbanites) and wood chips (refuse from urban street tree maintenance efforts) were situated to provide cover and hibernating and nest sites.

Having effected habitat improvements, the introduction of herps was begun, according to self-imposed restrictions on what is to be introduced. First, a list of 14 potential species was developed, with introductions to start with species of the lower trophic orders and to end with higher order predators. Secondly, animals had to be obtained locally, since Long Island is a distinct zoogeographical entity. Finally, populations from which collections were to be made either already had to be faced with extirpation or had to be large enough to sustain collecting without becoming extirpated. The goal was not to wipe out one population to establish another.

The amount of field work required for this type of project can be tremendous. Collecting is time consuming and there are many unknowns, foremost of which is "How many individuals are necessary to establish a breeding population of a given species?"

Since 1980, the project effort has concentrated on three species. Breeding pairs of Spring Peepers *(Hyla c. crucifer)* were collected on April nights from the freshwater marshes adjacent to the runways of nearby Kennedy Airport and released into the freshwater ponds of Jamaica Bay. Later on, tadpoles were netted at the airport and similarly released in Jamaica Bay.

Twenty-five Northern Brown Snakes *(Storeria d. dekayi)* were released in one secluded part of the refuge. Recaptures of marked individuals have shown survival after two months, but it still is too soon to know whether or not a breeding population exists.

Lastly, Eastern Box Turtles have been collected from a parcel of land in nearby Suffolk County slated for sub-division – the beginning of the end as far as the box turtle population is concerned. Finding these animals has been a slow process in which chance is a big factor, so it will take several years to complete work on this species.

This program to enhance an animal community is not one where dramatic results will occur overnight. Many more years of collecting, marking, and monitoring these animals and their habitats will be necessary to accomplish the overall objective – establishment of a balanced, self-perpetuating animal community as representative of pre-urban New York as possible. Considering trends in population growth and urban development, Jamaica Bay Wildlife Refuge and other Gateway natural areas may someday be the only places left in New York City where visitors can experience the native wildlife of the area.

Cook is a Park Technician at Jamaica Bay Wildlife Refuge, Gateway NRA.

GWS Strategy Conference on Resources Protection set Oct. 18-20 in D.C.

The George Wright Society's triennial meeting, Oct. 18, 19, and 20, 1982, in Washington, D.C., will consist of a Strategy Conference on the Protection of Natural and Cultural Resources: A Research and Education Agenda for North America.

The meeting will consist of two days of invited papers on topics that make up the spectrum of cultural and natural resource protection problems. Each speaker will be allotted approximately an hour – to outline and illustrate progress and problems in the subject area. Sessions will run concurrently with three each in the morning and afternoon of the first two days for a total of 24.

Part One will cover 12 subjects: The Natural Resources of National Parks, Natural Landmarks (including World Heritage Convention Sites), Marine and Estuarine Resources, Rivers and Trails, Wilderness, Urban Green Space, International Biosphere Reserves, Barrier Islands, State and Provincial Parks and Forests, Agricultural Ecosystems, Natural Resources of the Megalopolis, and Research Natural Areas and Research Parks.

Part Two will cover an additional 12 subjects: The Cultural Resources of National Park Systems, Historical Architecture, Cultural Resources in Public Ownership at the State, Provincial and Local Level, Historical Engineerings (including Industrial Archeology), Prehistoric Archeology, Historical Districts and Neighborhoods, Historic Archeology, Submerged Archeological Resources, Maritime Resources, Rehabilitated Historical Properties, Historical Landmarks (including special Historic Homes as of National Leaders), and Rural Cultural Landscapes.

A workshop will be convened the morning of the third day for each of the 24 topics, led by the speakers on each topic and aimed at a forward look at the subject matter and an assessment of "where do we go from here?" Eight raporteurs will be assigned to cover the 24 workshops, three workshops per raporteur.

The third day afternoon, the eight raporteurs will deliver the workshop reports to the conference and the meeting will be adjourned. Proceedings of the Conference will be published as an issue of the George Wright FORUM, and will include the 24 papers and edited workshop reports.

Aquatic Studies at Indiana Dunes

By Douglas A. Wilcox

The dunes along the southern tip of Lake Michigan are remembered in scientific circles for the pioneering work in ecology conducted there by such notables as Henry Chandler Cowles and Victor E. Shelford. Less well-known is the fact that the areas between the dunes generally contain water, exhibiting a variety of forms which includes peatlands, marshes, sedge meadows, hardwood swamps, interdunal and intradunal ponds, and small streams and rivers. Despite human settlement of the area long before Indiana Dunes National Lakeshore was established, many of the aquatic resources in the park retain much of their natural character. Unfortunately, some areas have been and continue to be threatened by human activities.

These threats resulted in the establishment within the park of a Science Division, consisting of a Chief Scientist and four professionals specializing in water resources, air resources, biology, and plant ecology, respectively. The issue attracting the most publicity and receiving the most attention from this science division was a threat to Cowles Bog National Natural Landmark from dewatering of the nearby construction excavation of Bailly Nuclear-1, a nuclear power plant whose construction had been delayed since 1977 by the Nuclear Regulatory Commission. Coupled with the dewatering issue was a problem of the opposite extreme, flooding of part of the wetland by seepage from fly ash settling ponds operated by the same electrical generating company.

The seepage problem was resolved by an agreement between the Department of the Interior and the power company that the company would seal the fly ash ponds. The dewatering threat persisted. Studies of the Cowles Bog National Natural Landmark began in 1979 with the intent of characterizing the true nature of the wetland, identifying any existing threats and impacts, and predicting the impacts that might result once nuclear plant construction resumed and dewatering of the excavation was increased.

Results indicated that the peatland was a minerotrophic, groundwater-fed fen, rather than a precipitation-fed bog, and that the groundwater source was a confined aquifer under hydrostatic pressure. As data continued to be collected, it became evident that Cowles Bog fit the definition of a spring mire: a convexly mounded peatland forming over a spring head, the height of the convex peat mass being a function of the hydrostatic head of the spring and the containing volume of the peat.

This discovery became very important when the power company determined that it would be necessary to actively pump water from this same confined aquifer at the excavation site as part of the dewatering activities. U.S. Geological Survey computer modeling predicted that the pumping could cause a decrease in the hydrostatic head under Cowles Bog, resulting in several possible negative impacts to the wetland. Before further research efforts were fully geared up or a full-fledged confrontation erupted, the issue was defused; the power company announced the termination of its construction plans for economic reasons in the late summer of 1981.

While the Cowles Bog controversy was raging, the other aquatic resources of the park were not neglect-

***Cowles Bog wetlands** are shown in this aerial photograph: the power company is in the foreground and the National Natural Landmark is indicated by the arrow in the background.*

***Pinhook Bog** is a road salt-impacted area, showing skeletons of dead tamaracks and invading cattails.*

ed. Monitoring of small streams and ditches and the Little Calumet River for numerous water chemistry parameters was coupled with aquatic fauna studies, especially on the "Little Cal," a salmonid migration stream integral to the Indiana Department of Natural Resources Great Lakes fishery program. Monitoring of beaches and streams for bacterial contents has resulted in numerous requests to county health departments to take action against landowners with faulty septic systems. High bacteria levels on several occasions at one of the Lake Michigan swimming beaches were traced to sewage treatment plants on the Little Cal that were unable to handle combined sewer loads during heavy rainfall periods. Studies conducted on many of the 150 interdunal/intradunal ponds in the 240 hectare Millar Woods section of the park have identified threats from human activities around the park periphery. These threats include an industrial landfill and road salt-laden runoff from a parking lot.

Road salt runoff has proven to be responsible for one of the most evident environmental impacts found in the park. Pinhook Bog, which occupies an ice-block depression in the Valparaiso moraine, appears to be isolated from mineralized groundwater flow and to rely on precipitation for its water supply. Runoff from a sodium chlorine (NaCl) road salt storage pile located on I-80/90 adjacent to the bog drastically altered the water chemistry of a portion of the bog, resulting in the death of many native bog plants and the invasion of more salt-tolerant plant species. The major study conducted here has shown an obvious correlation between aquatic vegetation changes and the salt concentrations of the water held in the root zone of the floating peat mat. More importantly, the salt concentrations in the root zone have been shown to be decreasing as heavy rainfalls have leached the salt to lower levels. The native vegetation, especially the sphagnum mosses, have reponded to the recovering water chemistry by reappearing in areas where earlier they had been eliminated.

The recovery of Pinhook Bog can be attributed, in part, to the working relationship between science and management. Recommendations from science to park management resulted in the termination of salt storage activities at the site by the highway department and alteration of the highway drainage system to reduce direct runoff from the highway into the bog. This has allowed natural processes (precipitation) to ameliorate the problem.

The Cowles Bog study, the Pinhook Bog study, and nearly all the other studies conducted by the Science Division are in response to the needs of park management. Intelligent management decisions must be based on accurate information, which is often available only after detailed study by professionals in the field. In that light, future water-related work at Indiana Dunes will involve continuation of many of the current studies and the addition of a few more. Emphasis will be placed on studying changes in the Cowles Bog wetlands following termination of fly ash pond seepage and identifying the nature of materials that leach from the industrial landfill into the surface and groundwater systems in Miller Woods. As with much of the work done by the Science Division at Indiana Dunes, input from several staff disciplines can enhance the value of the research being conducted, reflecting the importance of adequate science staffing at the park level.

Wilcox is the Water Resource Specialist at Indiana Dunes National Lakeshore.

Carrying Capacity Project Underway

In line with the generally recognized need to define the level of human use that can occur in a given natural system before resource degradation takes place, the National Parks and Conservation Association (NPCA) is assisting the NPS in a new attempt to define carrying capacity in parks.

In 1978, Congress passed the National Parks and Recreation Act (P.L. 95-625), Section 604 of which states that: "General management plans for each unit (of the NPS) shall include, but not be limited to: *** (3) identification of and implementation commitments for visitor carrying capacities for all areas of the units."

NPCA, funded by a foundation grant, has contracted with the University of Maryland to examine the current state of carrying capacity development for land managing agencies. The first step will include a literature search of all research, with emphasis on research from the parks. The final product will serve as an initial evaluation and synthesis, documented in a report with recommendations. The final synthesized approach to determining carrying capacity will then be tested in several park areas, as methodology refinement and improvement continue.

The stated goal is to provide some consistency in park management's approach to human user limits.

NPCA is appointing a 30-person panel to overview the process and review recommendations. In all, about 15 NPS employees will participate, including superintendents, representatives from sociology (Don Field), DSC, and WASO (Ro Wauer). NPS participation will include two or three meetings and some review of materials by mail. NPCA is considering a symposium on carrying capacities upon completion of the contract work.

Clark Named To PNR Post

Shirley Clark recently was named Air and Water Quality Coordinator for the Pacific Northwest Region. She is responsible for the regional programs involving visibility, air quality monitoring, prevention of significant deterioration (PSD) permits, and acid precipitation analysis.

Before surfacing in this new assignment, most of her work centered on compliance with the National Environmental Policy and Clean Air Acts. Creation of

the new coordinator's position, in the Division of Science and Technology, will enable the Park Service to better utilize her scientific air and water quality analysis skills.

Shirley has a B.A. in biology from Park College, Parkville, Missouri and M.S. in limnology from the University of Washington. In graduate school her work dealt primarily with water quality studies. After college she worked for two years as a biology instructor at Simmons College in Boston. Clark began her public service career with the Bureau of Commercial Fisheries and has been with NPS since 1972.

Fire Management Softwear Developed

A software proposal (FIREPRO), approved by the ADP Executive Review Board in Washington in April, is scheduled for completion Nov. 1, 1982, according to Scott Erickson, Branch of Fire Management, 3905 Vista Ave., Boise, ID 83705.

The software package is being developed on the basis of information manually run in 13 NPS pilot areas ranging in size from San Juan Island to Yosemite and the Big Cypress. The computer program will first be run through on these 13 areas, after which FIREPRO will be used to analyze the 96 first priority parks in the System. Erickson, who is key person for the project, estimated that all 96 park analyses should be completed between December 1982 and February 1983.

The package will enable computer analysis of fire management programs such as fire occurrence, fire weather observations, and National Interagency Fire Qualification System. Outputs will include fire season, normal fire year, organizational complexity, required initial attack personnel, and a summary of presuppression, acquisition, and prescribed burning needs. The U.S. Forest Service computer in Fort Collins, CO will be used when the FIREPRO package is complete.

research note

The second Annual Report for the University of Idaho, CPSU, profiling all the research and other activities undertaken by the Unit in 1981 contains a description of a project using social indicators to help monitor ecological change in the Olympic NP Biosphere Reserve. Variables chosen by Gary Machlis for this experiment, on the basis of their potential to impact the Reserve, were population growth, exploitation of natural resources, industrial development, and tourism. Social indicator selection was based on three criteria: availability, time frame (data collected over greater time periods being preferred) and relevance to ecological conditions of the Reserve. Several indexes were developed and these statistical series were combined into a report for Olympic NP managers.

A Boreal Forest Park: Problems and Approaches

By Glen F. Cole

Editor's Note: *It is the policy of* Park Science *to hold footnotes, literature cited, and extensive use of Latin names to a minimum. However, in some cases the Bulletin's goal of reporting science in the parks in terms of management of the parks can be better served by adhering to a journal-like style. The questions addressed here, both scientific and managerial, can best be considered in the light of all the information contained in the literature cited. For that reason, the guidelines have been eased to accommodate this article's form and style.*

The Park

Voyageurs National Park is in northern Minnesota and borders Canada on the north and east (see map). About two-thirds of the park is land and the remainder is made up of numerous lakes. Lake and land areas show the effects of glaciation that exposed Precambrian bedrock.

Voyageurs is the only U.S. national park on the mainland in a southern boreal forest region. Isle Royale is also in this region, but it has a characteristic island biology.

Explorations for gold, uncontrolled hunting and fishing, logging, homesteading and finally resort and summer home development occurred after the area was unsuccessfully proposed as a park in 1891. The park was finally established in 1975 and is to be administered in accord with the Act of 1916 (36 Stat. 535) and its amendments and supplements (16 U.S.C. 1-4). These Acts of Congress require that the park preserve representative examples of its scenic natural environments and native wildlife to the extent possible.

The establishment of the park led to research on its vegetation and wildlife. Research results are in a series of technical reports.[1-5] The following brief summaries of original and present conditions are from the data in these reports. Final recommendations attempt to follow the park's legislative mandate.

Original Conditions

Early land survey and logging records show original forests were a disturbance-influenced mosaic of different kinds of climax, subclimax and seral vegetation. Uplands mainly had spruce-fir *(Picea glauca - Abies balsamea),* Pine *(Pinus strobus, P. resinosa* or *P. banksiana)* or aspen *(Populus tremuloides)* dominated communities. Lowlands had black ash *(Fraxinus nigra)*, eastern white cedar *(Thuya occidentalis)*, willow *(Salix spp.)*, alder *(Alnus rugosa)* or muskeg (stunted black spruce, spagnum moss and evergreen shrubs) dominated communities.

This diverse vegetation supported populations of four different cervid species. Woodland caribou *(Rangifer tarandus)* and moose *(Alces alces)* were more abundant than either white-tailed deer *(Odocoileus virginianus)* or elk *(Cervus elaphus)*. These, and other smaller herbivores, supported a characteristic predator and scavenger fauna that included the eastern timber wolf *(Canis lupus)*, wolverine *(Gulo lucus)*, Canada lynx *(Lynx canadensis)*, fisher *(Martes pennanti)*, pine marten *(Martes americana)*, raven *(Corvus corax)* and bald eagle *(Haliaeetus leucocephalus)*. Other records show the area's large lakes originally had extensive beds of wild rice *(Zizania palutris)* and indicate that a variety of associated fish and wildlife species were more abundant than at present.

Present Conditions and Causes

Logging and/or associated fires, mainly between 1913 and 1936, changed portions of the pine and spruce-fir communities on uplands to aspen communities. Natural succession and disturbances will reestablish representative natural conditions on these areas and maintain such conditions on other park areas. However, the present practice of suppressing all fires as rapidly as possible will eventually allow pines to be replaced by other vegetation, reduce other types of diversity, and increase the opportunities for catastrophic fires or insect outbreaks.

Uncontrolled hunting eliminated woodland caribou and elk from the region and reduced the moose population to such a low level that loss of genetic diversity due to inbreeding may prevent recovery. White-tailed deer temporarily increased following logging, but have since declined – initially because of forest succession and more recently, the additive effects of wolf predation. Calculations suggest that these overall declines in the numbers and kinds of native cervids have reduced the amount of winter and early spring food that they supply for native predators and scavengers to one-third of what it was originally.[1] Species

Location and boundaries of Voyageurs National Park.

such as the wolverine and Canada lynx no longer occur as breeding populations and the park's wolves and bald eagles are declining. In contrast, abundant food exists for woodland caribou, moose or elk (if moose densities remain low) because the niches for these species are essentially vacant.

Dams constructed at the outlets of Rainy and Namakan Lakes in the early 1900s also have influenced park ecosystems. Periodic reports by Canadian and U.S. engineers (park files) show that yearly water level fluctuations with the dams have averaged 1.1 meters (3.6 feet) in Rainy Lake and 2.8 meters (9.3 feet) in adjoining Namakan, Kabetogama, Sand Point and Crane Lakes. Calculated "natural" fluctuations over this same 1909-1980 period averaged 2.0 meters (6.7 feet) in Rainy Lake and 1.9 meters (6.4 feet) for the Namakan chain of lakes. These calculated values seem high in comparison to actual measurements of natural fluctuations in adjoining Lac La Croix, which averaged 1.6 meters (5.3 feet) from 1929 to 1981.[6] Until the accuracy of calculated "natural" levels can be checked, the Lac La Croix average is considered to approximate what the mean natural fluctuations would be in both Rainy and the Namakan chain of lakes.

Regulated fluctuations also have differed from natural fluctuations in timing by their usually having lake levels rising through, instead of peaking, in June and usually having July peaks; by having stable instead of generally declining levels over summer and fall; and, in the case of the Namakan chain, by having declines of about 1.8 meters (6 feet) instead of about 1.1 meters (3.6 feet) over winter (November-March). In the Namakan chain of lakes, the once extensive beds of wild rice have been replaced by other aquatic vegetation in response to the changed water regime, and the greater over-winter water level declines leave beaver and muskrats without shelter or food and dewater northern pike *(Esox luscius)* spawning areas. In all four lakes, the rapidly rising lake levels through June regularly flood the nests of shore and marsh nesting birds, and the stable lake levels over summer and fall allow sand or silt to accumulate on walleye *(Stizostedian vitreum)* spawning areas.

Recommendations

Based on the data summarized above, the following actions seem necessary to preserve representative examples of natural southern boreal forest environments and their native wildlife in Voyageurs National Park:

1. Allow natural fires and/or prescribe burn within sub-units, where fires can be confined, to maintain pine stands and other kinds of vegetational diversity and reduce the opportunities for large catastrophic fires or insect outbreaks to occur;

2. Reestablish viable woodland caribou, moose and/or elk populations to restore food for native carnivores, develop a more representative native fauna, and increase opportunities for park visitors to see wildlife;

3. Approximate the magnitude and timing of natural fluctuations in lake levels, except in years with unusually high or low precipitation, to reduce the frequency of adverse water level effects on wild rice, fish, and other wildlife without conflicting with flood control, navigation needs or other authorized uses of water.

The first two actions initially can be carried out on a small scale and critically evaluated by applied research. This approach has been used in other national parks[7-8] and should show the most effective ways to carry out operational programs. Small scale reintroductions of native cervids also could test various hypotheses and wildlife managment concerns about the effects of parasites in mixed cervid species systems[9] and about the impact of inbreeding in moose.

The third action, effecting changes from the present system of regulating lake levels, would have to be authorized by an International Joint Commission. Because Rainy Lake has three times the storage capacity of Namakan, Kabetogama, Sand Point and Crane Lakes combined, allowing it to fluctuate 1.5 instead of the present 1.1 meters (0.4 m lower) could reduce the fluctuations in these other lakes from 2.8 to 1.6 meters (1.2 m from these becomes 0.4 m in Rainy). With mean fluctuations of about 1.5 meters in Rainy and 1.6 meters in the other lakes, runoff peaks in June instead of July, summer to fall declines of 0.4 meters in Rainy and 0.5 meters in other lakes, and over winter declines of 1.1 meters in all lakes, almost the same amount of water (about 2% less) is stored over winter as with the present mean fluctuations. Adjustments can easily be made to store the same amount of water if this is considered essential. The ecological effects of these or any other changes from the present regulation system also could be monitored and evaluated by applied research.

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***Two captive-reared** peregrine chicks are rapelled to the nest by Rob Roy Ramey of the Predatory Bird Research Group at Santa Cruz. (Photos by Oregon Dept. of Fish and Wildlife.*

Peregrine Rescue Efforts Continue at Crater Lake

By Mark Forbes

The peregrine falcon is on the brink of non-existence in Oregon. In the 1930s there were 39 known active peregrine nests; today there is only one, at Crater Lake National Park. The pair of birds that use this site have had only marginal reproductive success the last few years.

Peregrine falcons have been observed within the park since the late 1800s. Reports of single birds were received, but no pairs were seen until July 1979, when a USGS research party working inside the caldera observed three peregrines and reported the information to Park officials. The U.S. Fish and Wildlife Service (USFWS) was informed and a research biologist from that agency was sent to the Park. After a day of searching the nest site was located. It was determined that the site was active, the peregrines had successfully fledged two young, and that one addled egg remained in the nest. The birds were observed for the remaining summer months and after their fall departure, a National Park Service team descended into the nest to retrieve the addled egg and any prey remains.

The recovered material was sent to the USFWS for analysis. This analysis closely paralled data gathered from other addled peregrine eggs: Egg shell thinning was 19 percent and DDE shell levels were 19 parts per million (ppm).

The steady decline in peregrine populations has been tied directly to the use of the pesticide DDT. Residues of DDT and subsequent by-products DDE, DDD and others were rapidly spread throughout the world after the chemical came into widespread use in the mid 1940s. This contamination is associated with eggshell thinning and reproductive failure among a number of bird species, including the peregrine.

Eggs with thin shells are easily broken or damaged during incubation but an even more serious problem is dehydration, which causes embryos and developing chicks to die before hatching. The peregrine population dropped so low in the U.S. that the species was listed as endangered.

In 1980 it was decided to observe the nest site but take no direct management action to assist in the reproductive success of the birds. The pair returned to the site in the spring and laid three eggs, none of which were viable. The eggs were recovered in early September and sent for analysis. The results were the same as in 1979: 18-19 percent shell thinning with an 18 ppm DDE level.

The Crater Lake NP staff met with the USFWS, Oregon Department of Fish and Wildlife (ODFW) and the Predatory Bird Research Group (PBRG) during the fall and winter of 1980-81. A management plan was written following the guidelines established in a draft Pacific Coast Peregrine Falcon Recovery Plan. The park's plan was submitted to the USFWS for formal consultation and approved as required under Section 7 of the Endangered Species Act of 1973. The consultation process required almost two months with approval given two days before the management action was planned.

This plan called for a site "manipulation" involving personnel from several agencies and organizations. Climbers from PBRG would rappel into the site, remove any eggs and in turn replace captive-bred young. The technique had been developed and refined by Cornell University and the Peregrine Foundation at Fort Collins, CO. The PBRG located at the University of Santa Cruz had performed similar manipulation in California and was willing to assist on the Crater Lake project.

A nest site observer had been hired in early April to watch the birds, record their activities and establish when the female laid the clutch of eggs. The individual hired was ideally suited for the assignment. He had worked with the FWS rehabilitating injured peregrines, he could cross-country ski to the site, and he enjoyed the solitude and isolation of the assignment.

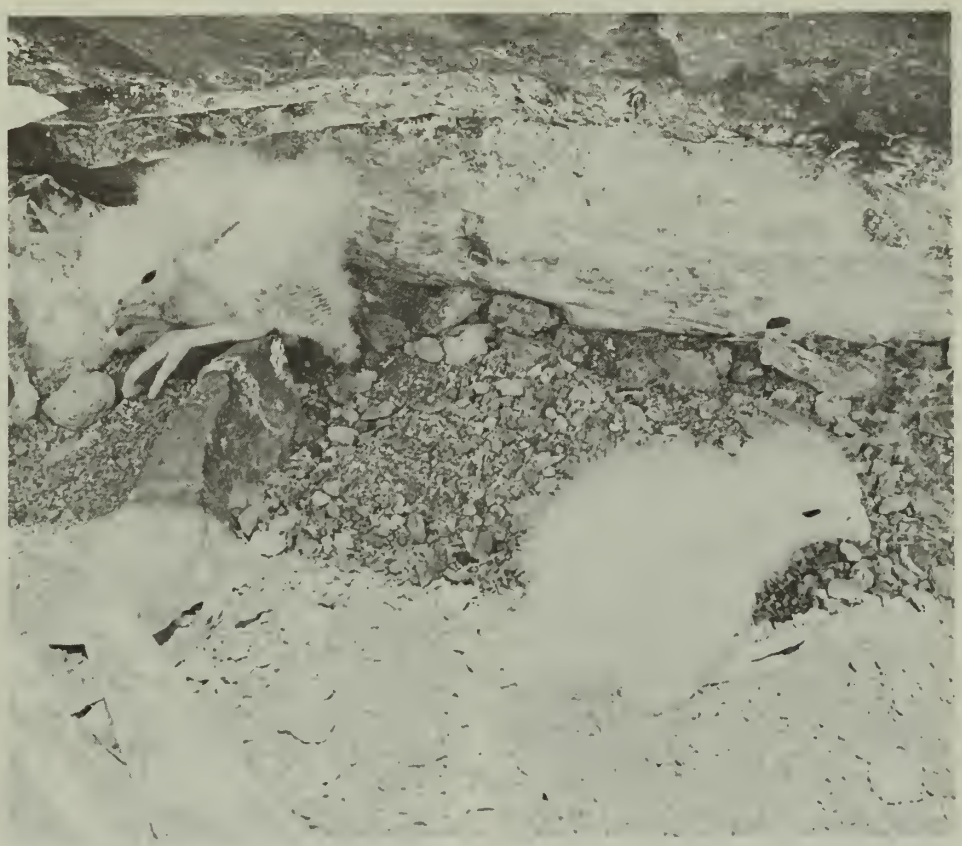
The peregrines returned and began their courtship in early April. By the end of the month, three eggs had been laid. The manipulation was scheduled for 10 days following the egg-laying date. This time period was critical to ensure acceptance of transplanted birds yet minimize potential for egg dehydration.

Several days were needed to organize logistics of air and land travel, with each mode of transportation located in the best possible position. Considering the potential for error, the manipulation process went smoothly.

The young captive-bred chicks were flown to the site by helicopter and hand carried to the staging

Adult peregrine *makes angry circles in the sky as workers visit the nest.*

Hand puppet *fashioned to resèmble an adult peregrine is used to feed falcon chicks – shown here being given a last meal before being placed in the nest. This feeding method is used to help chicks "imprint" on adult birds rather than humans.*



***Rocky ledge** serves as a peregrine nest. Here the two introduced chicks huddle and await discovery and acceptance.*

area. A climber from the PBRG rappeled into the nest with the young, removed the three eggs and was back on top within 23 minutes. The adult female had begun brooding the chicks before the climber had reached the top. The two young were successfully raised by the adults and fledged 3-1/2 weeks after the manipulation.

The eggs were taken to the PBRG facilities where they were specially treated with wax to prevent dehydration. Two were hatched in mechanical incubators but the third was found to be dead. The two young, both females, were retained at the facility to be used in the captive breeding program. One was later mated with a male bird from Yosemite NP which had been injured in a fall from its nest.

The eggshell analysis results were similar to the previous years and indicated that the eggs would have failed had they been left in the nest. By all standards the manipulation was successful in fledging two young in the wild, and the artificial hatching of two wild eggs which otherwise would have failed.

The manipulation process was repeated this year. Again three eggs were removed and replaced with two healthy young. The two young have successfully fledged; however, all three wild eggs were found to be addled. Preliminary date indicate the eggs died within the first week of being laid and before the transfer was effected.

Costs for this project were shared by the NPS and ODFW. The NPS funds were all from the park's operating budget. The State's portion was a special non-game wildlife fund contributed by Oregonians through tax donations. The program at Crater Lake will continue for at least three more years. The ODFW will expand its involvement in re-establishing peregrines in the state. Two sites have been located which are ideal habitat. Captive breed young will be introduced into the wild through a "hacking" process, possibly to reoccupy historic nest sites in future years.

Such measures might seem futile, were it not for the hope that the long lived pesticide, DDT, will decline and the levels that reach raptors like the peregrine will subsequently diminish. Meanwhile, efforts will continue to insure the reproductive success of the peregrine until environmental conditions improve.

Forbes is a Resource Management Specialist at Crater Lake NP. All photos are courtesy of the Oregon State Dept. of Fish & Wildlife.

NOTICE!!!

The Northern Yellowstone Elk: Ecology and Management by Doug Houston will be published by Macmillan and Co. in October. NPS installations wishing to purchase the book at pre-publication discounts should contact Linda Jackson of Macmillan, 866 Third Ave., New York, NY 10022, (212) 935-2004. Discounts will vary according to the number of copies ordered. The 500-page book, with 160 illustrations, is destined without doubt to be considered – for years to come – the definitive work in the field.

regional highlights

Alaska Region

Francis J. Singer, research wildlife biologist, is now stationed in the Alaska Region, having arrived there by way of Glacier NP, following a four-year stint at Great Smoky Mountains NP. His work there was largely on ecology, numbers and impacts of exotic European wild boar. A list of published reports by Singer and available from him at the Alaska Regional Office, 540 West Fifth Avenue, Anchorage, AK 99501, includes:

"Wild Pig Populations in the National Parks," in *Environmental Management,* Vol. 5, No. 3, pp. 263-270; "Home Ranges, Movements, and Habitat Use of European Wild Boar in Tennessee," in *Journal of Wildlife Management,* Vol. 45, No. 2, pp. 343-353; "Forage Relationships of European Wild Boar Invading Northern Hardwood Forest," in the *Journal of Wildlife Management*, Vol. 45, No. 3, pp. 748-754; "Food Availability, Reproduction, and Condition of European Wild Boar in Great Smoky Mountains NP," Research/Resources Management Report No. 43 (available from Uplands Field Research Lab, Great Smoky Mountains NP, Gatlinburg, TN 37738); and "Some Ecosystem Responses to Wild Boar Rooting in an Eastern Deciduous Forest," written with Wayne R. Swank and Edward E.C. Clebsch in 1981, also a Research/Resources Management Report for the Southeast Region, and available from headquarters in Atlanta.

Rocky Mountain Region

Papers delivered at the Kalispell, MT conference, "Toward the World Biosphere Reserve: Exploring Relationships with Adjoining Areas," will be published as a Proceedings near the year's end. Following is a list of the authors and titles of the papers they presented at the June 22-24 conference:

Kenton Miller, IUCN-CNPPA, "Biosphere Reserves in Concept and Practice;" Tony Bull, Parks Canada, "An Overview of the Situation with Respect to Waterton Lakes National Park;" Thurman Trosper, Ronan MT, "An Overview of the Situation with Respect to Glacier National Park;" Charley Russell, Twin Butte, Alberta, "A Perspective from the Ranching Community;" C.J. Martinka, Glacier NP, "A Wildlife Management Perspective;" Ted Nicholson, Oldman River Regional Planning Commission, "A Regional Planning Perspective;" Will Holland, Canadian Forestry Service, "A Forest Management Perspective;"

John Marsh, Trent University, Ontario, "Research and Monitoring Needs in Managing Humans in Biosphere Reserves;" Walter Moser, University of Alberta, "The Case of Obergurgl, Austria;" Jack Stanford, University of Montana, "Desirable Approaches to Ecosystem Research and Monitoring in Biosphere Reserves;" Barry Sadler, University of Victoria, "Research, Monitoring and Education in the Canadian Rockies and Adjacent Lands;" Ray Herrmann, NPS

Water Resources Lab, "Desirable Types of Baseline Studies in Biosphere Reserves;" Valerius Geist, University of Calgary, "Necessary Wildlife Management Programs in Biosphere Reserves;" Stephen Kellert, Yale University, "Enhancing Public Appreciation of the Role of Biosphere Reserves: Some Educational Prerequisites;" Boy Evison, Sequoia/Kings Canyon NP, "How Do We Monitor the Effectiveness of the Biosphere Reserve?";

John Atkinson, Reid, Crowther and Partners, Ltd., and Marty Martinson, Parks Canada, "The Solid Waste Solution: Introducing a Centralized System in Banff NP and Adjacent Lands;" Mike Fay, Parks Canada, "Riding Mountain NP and Adjacent Lands: A Model Approach;" William Worf, U.S. Forest Service (ret.), "Developing Service Programs to Meet the Challenge of Biosphere Reserves;" R. Michael Wright, World Wildlife Fund, "Providing Funding for Biosphere Reserves and Similar Areas;"

Jeffrey A. McNeely, World National Parks Congress, "Biosphere Reserves and Human Ecosystems;" Ossie Lindquist, University of Kuopio, Finland, "Biosphere Reserves from the European Perspective;" Effendy Sumarjda, Indonesia, "Biosphere Reserves from the Southeast Asian Perspective;" Bruce Wilcox, Stanford University, "Biosphere Reserves and the Preservation of Biological Diversity;" William P. Bregg, NPS, "The View from the United States;" George P. Francis, University of Waterloo and Canada/MAB, "The View from Canada;" and Harold Eidsvik, World National Parks Congress, "A Global Perspective."

WASO Region

The Urban Forest Soils Workshop held in April at the University of Maryland's Center for Adult Education was co-sponsored by USDA-Forest Service through the Consortium for Environmental Studies, State University of New York – College for Environmental Science and Forestry, and the National Capital Region – NPS. There were fifty-two registrants for the 2½ day workshop, which included two informal evening information exchange sessions.

The Monday afternoon session focused on general soils information followed by hands-on soil texturing, a look at soil drainage classes in the field and an opportunity to observe a natural soil profile in the field.

Tuesday's activities consisted of an all-day field trip through the parks of NCR to observe trees and plants in their urban settings with the focus on urban soils and soil management techniques.

Wednesday in the classroom dealt with case studies, new product review, problem soil situations, amending existing soil situations and most importantly interacting early in the planning activities for proposed sites.

We have had considerable feedback from participants and have been requested to perform a similar task at North Carolina State University and at the American Society of Landscape Architects (ASLA) meeting in West Virginia. Others have expressed similar interest.

The workbook has been published and is available from: Dr. David Karnosky, Executive Secretary, Consortium for Environmental Forestry Studies, C/ Cary Arboretum, Box AB, Millbrook, NY 12545.

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The Natural Science Division announces publication of two Ecological Services Bulletins (ESB) and another publication in the Scientific Monograph Series. Numbers 6 and 7 in the ESB series are *Dutch Elm Disease and Its Management*, and *Herbicidal Control of Firetree in Hawaii Volcanoes National Park: A New Approach. Ecology and Social Behavior of the Collared Peccary in Big Bend National Park* is the 16th publication in the Scientific Monograph Series.

Gary Johnston, science editor for the Natural Science Division, expects publication of three additional manuscripts later this year. They are *The Climate of Yellowstone and Grand Teton National Parks, Ecology of the Saguaro III: Growth and Demography,* and *The Value of Conserving Genetic Resources.* Copies of the Scientific Publications List and Reprint List are available by writing to the Natural Science Division (494), National Park Service, U.S. Department of the Interior, Washington, D.C. 20240. Guidelines for submitting manuscripts for publication in the Servicewide Publications Program have been distributed to the Regional Chief Scientists; researchers who want to submit manuscripts should contact their Chief Scientist for copies of the guidelines, Johnston said.

Western Region

An update on the latest (April 30, 1982) volcanic eruption in Kilauea Caldera was a highlight of the Fourth Conference in Natural Sciences, held June 2-4 at Hawaii Volcanoes NP and co-sponsored by NPS and the University of Hawaii CPSU. Presentations by 51 individuals were given to the 101 registrants, with special sessions on Hawaiian goose (nene) biology and management, *Metrosideros* (ohia) dieback, and research and management of Hawaiian Park resources, especially exotic plants and animals.

Agendas are available from C.P. Stone, research scientist at Hawaii Volcanoes NP, HI 96718; late this summer the Proceedings may be obtained from C.W. Smith, CPSU director, Botany Department, University of Hawaii at Manoa, 3190 Maile Way, Honolulu, HI 96822.

⁂

Four publications by Dave Parsons, research scientist at Sequoia/Kings Canyon NP in California are now available from Parsons at the park. They are "The Historical Role of Fire in the Foothill Communities of Sequoia National Park," in *Madrono*, Vol. 28, No. 3. pp. 113-120; "Survival of Severe Drought by a Non-Sprouting Chaparral Shrub," (with Philip W. Rundel, Richard P. Hedlund and Gail A. Baker), in *American Journal of Botany*, Vol. 68, No. 7, pp. 973-979; "Establishing Backcountry Use Quotas: An Example from Mineral King, California," (with Thomas J. Stohlgren and Paul A. Fodor), in *Environmental Management*, Vol. 5, No. 4, pp. 335-340; and "The Role of Fire Management in Maintaining Natural Ecosystems," from *In Fire Regimes and Ecosystem Properties*, USDA Forest Service General Technical Report WO-26, pp.469-488, 1981.

Pacific Northwest Region

The U.S. Army Corps of Engineers is soliciting published or unpublished literature dealing with any aspect of raptor ecology in the Pacific Northwest, including management plans, distribution, food habits, productivity, surveys, theses, dissertations, etc. The Corps is compiling the information for a Raptor Reference Manual, designed to consolidate the considerable research that has been conducted in the Northwest, much of which is unpublished and/or generally unknown. This state of affairs has led to duplication or lack of research and/or management efforts, difficulty in referencing obscure but relevant literature, and intensive research into certain species and habitats with others being relatively ignored. Reference material for this manual should be sent to Tracy L. Fleming, P.O. Box 102, Rosalia, WA 99170. Phone (509) 523-5085.

⁂

Jim Agee, research biologist stationed at the University of Washington CPSU in Seattle, has been named by the Washington Commissioner of Public Lands to an 18-member advisory committee to help the Washington Department of Natural Resources prepare managment plans for its proposed 13,500-acre Tiger Mountain State Forest southeast of Issaquah, WA.

⁂

"Foreign Visitors and Interpretation: A Sociological Look at the Japanese Tourist," by Gary Machlis, Donald Field, and Mark Van Every, was published in May as University of Idaho CPSU S82-1. The secondary data presented provide a description of the distribution of Japanese visitation to the U.S. with special emphasis on implications for interpreting to this special visitor population. The report is the first in a series on foreign visitation being prepared by the Pacific Northwest Region's science staff. The second report, on a pilot study of foreign visitation to Grand Canyon, will be completed and distributed shortly.

⁂

A 25-page report on the January 27-28 Crater Lake research planning meeting and workshop, hosted by the CPSU on the Oregon State University campus, is now available. Selected research results given at the meeting are summarized in the report, available from James Larson at PNR headquarters in Seattle.

Midwest Region

Beginning in summer 1982, the Midwest, Southwest, and Rocky Mountain Regions will cooperate in contracting for studies of prairie communities in parks in the Great Plains as one of the Washington Science Office's Interdisciplinary Programs. Initially, a list of parks with prairie and the type, acreage and condition of prairie within these parks will be produced. The studies will identify and consolidate known information on prairie management and management technology into formats and guidelines useful to the park resource manager.

Ever Tougher Fight Faces Everglades Over Water Rights

By Gary Hendrix

Certainly to some, the Everglades water problems must seem like a soap opera: When you tune in the show's still on, and the actors are the same only older. And too, a like soap opera, the story seems to go on and on, exploring every possible twist in "The Predicament." Everglades's predicament happens to be that it must share its replenishing waters with more and more people in south Florida. The park is in constant negotiations with its neighbors. In fact, it's a tough battle just holding on to the water resources we have, let alone getting the additional amounts we think we need. All parties must plead their cases with one another, and those cases have to be pretty convincing to win much in the water game.

Sometimes even the most ardent bargaining hasn't worked. Indeed, the U.S. Congress had to intervene in 1970 to get at least a minimum yearly amount of water for the park. As might be expected in this competitive arena, the minimum soon became regarded also as the maximum. Some of the park's more aggressive neighbors felt that the park had been taken care of, and the water left over was up for grabs or should be drained away. However, Congress in its wisdom, acknowledged that its 1970 intervention was based upon a limited understanding of the Everglades, and that more information might justify a change in the park's share of upstream waters. Therefore, the Army Corps of Engineers was directed to prepare, by 1984, a report to Congress on any change in the park's water needs that might result from an increased understanding of the Everglades. The clock's still ticking and 1984 looks very close.

Shark Slough research team members: *seated (l to r) Ingrid Olmsted, plant ecologist; Gary Hendrix, research director; Bill Loftus, fishery biologist; kneeling, Terri Jacobsen (left), wildlife biologist, and Jim Kushlan, wildlife ecologist; standing (l to r) David Sikkema, hydrologist; Mark Flora, hydrologist; Pete Rosendahl, hydrologist; Jim Tilmant, marine biologist.*

Wildlife technicians, *radio tracking collared alligators from an airboat, to determine home ranges.*

Where do we find ourselves? What have we learned? Has the guaranteed minimum water delivery saved the park?

In the last twelve years that the park has received the Congressional schedule of water, we have documented a steady decline in the number of wading birds nesting and feeding in the park. Moveover, a forest of exotic trees, which thrives in marshes that dry out quickly, is advancing menacingly into the central Everglades drainage. In addition, local fishing interests claim that park estuaries fed by the Everglades are no longer productive and blame it on reduced fresh-water flow. Clearly something is wrong in the Everglades and Congressional help won in 1970 may have to be asked for again.

As if these weren't enough problems for the National Park Service to sort out, major land development began in the watersheds east of the park in 1976. The park had long enjoyed a wide buffer between its eastern boundary and the edges of Miami's agricultural fields. The east Everglades contains the headwaters of one of the most important drainages to Florida Bay, Taylor Slough, and a large portion of the main park drainage, Shark Slough. Uncontrolled development in this area is a serious threat to the survival of Everglades National Park. Fortunately for Everglades, many local people not only saw it as a threat to the park, but a threat to their own water sup-

ply and loss of an important recreational area. All agreed something had to be done.

The park and the National Park Service realized that some very serious problems were looming in the Everglades' future and, in 1977, launched a major research effort to design a better water management scheme for the park. This also meant developing closer working relationships with those park neighbors who wanted to bring some sanity to south Florida's water problems. To this end, the park joined with Dade County and several state agencies forming a work committee to develop a land use plan for the east Everglades which would both allow prudent use of the area and would protect the county's water supply and those water sheds so important to the park. Utilizing a grant from the Environmental Protection Agency, the committee gathered the large resource data base necessary to write plans and implement the necessary protective legislation.

At the same time all of this was unfolding, the park and the local water management district co-sponsored a project with the Army Corps of Engineers to study water delivery problems affecting the park's major drainage, Shark Slough. These two efforts, the East Everglades Plan, and the Corps' study of Shark Slough have been immensely effective in getting local attention focused on the park's water dilemma. However, now that we have peoples' attention, we have to suggest some workable alternatives to the Everglades' problems. These alternatives not only have to satisfy our needs, but must seem practical and beneficial to the park's neighbors.

Developing and evaluating water management alternatives is the highest priority assignment for our research team at the South Florida Research Center. Shark Slough, because it is the largest drainage and subject to intense external management, has become the main focus of this research. As with many intractable questions, we've had to dance around this research problem looking for insights that would lead to a real solution. We've adopted a loose team approach allowing for several premises about water conditions in the Everglades to be explored simultaneously.

Pete Rosendahl and his team of hydrologists started from the premise that if we could return to historical water conditions, which fluctuated with seasonal rainfall, the ecology of the Everglades would restore itself in due course. Realizing that this condition might not be achievable with today's vastly altered watershed, hydrology is taking three research tracks: First, determine what were the historical water conditions; next, evaluate how the present system of canals, levees and water schedules affect water conditions inside the park; and finally, consider what possible engineering and hydrological practices might be changed in today's water management system in order to approximate historical Everglades water conditions. At this time, several of the hydrologists' alternatives are being tested on the local water management district's water shed model.

The biologists, on the other hand, have explored water management options from a slightly different perspective. Jim Kushlan and his team of wildlife biologists are seeking first to unravel the intricate web that links the fortunes of wildlife populations to water conditions and then, to reconstruct that web to propose a pattern of water conditions that would best sustain a productive marsh ecology with the traditional Everglades diversity. This is no easy task; Dr. Kushlan has focused his attention primarily upon how the ups and downs of water management practices affect three wildlife populations: alligators, fresh-water fish, and wading birds.

What the wildlife biologists have found thus far is that the rate at which the marsh floods, and then later dries, is extremely important in stimulating wildlife productivity. Unfortunately, our past water delivery operations have all too often ignored this essential element. Indeed, water released to the park more often reflects the upstream users' need to withhold or drain away water than it does the conservation of Everglades health.

There are two aspects of Everglades ecology where our understanding still is preliminary. We know very little detail yet on how water conditions change

Perched in the top seat *of an airboat, Hydrologist Pete Rosendahl records water depths and conductivity at one of 35 hydrological stations within Shark Slough.*

Ingrid Olmsted *makes notes from a canoe on the plant life of Shark Slough.*

marsh vegetation and estuary communities. Initial work on Shark Slough plant communities is being done by Dr. Ingrid Olmsted. In addition, both Dr. Olmsted and Lance Gunderson have surveyed the spread of exotic plants into wetland habitats. Since these kinds of vegetation studies unfold over long periods of time, our research and monitoring efforts will have to continue several years more to match our information on wildlife and hydrology.

Everglades estuaries always have enjoyed a reputation as some of the most productive fishing habitats in the world. Something has eroded their health, and we're all anxious to discover what is wrong. We suspect that changes in Everglades' flow into the estuaries has a great deal to do with the problem. The zone between the upland marsh and the marine world is recognized by researchers everywhere as one of the most complex habitats. Nonetheless, marine biologist Jim Tilmant and his team have launched several studies seeking out the important relationships between estuary environmental conditions and estuary productivity. Initially, they are examining estuary fish populations and their supportive food chains, but eventually we know that our work must examine the more complex relationships between fresh-water inflow and the salinity and nutrient patterns in the bays.

The challenge now is to bring all these hydrological, wildlife, vegetation, and estuary approaches together for the 1984 report to Congress. None of us expects that our work will stop with the report. Refinement and longer term studies will be needed to implement any water management plan – but, our next and maybe last shot for awhile for something better appears to come in 1984. The most likely prediction for the Everglades is that water problems will go on but the bargaining will get tougher. The National Park Service's investment in research and understanding of the Everglades will improve the park's hand in the next round of the water game.

Hendrix is research director at the South Florida Research Center at Everglades NP.

letters to the editor

Editor's Note: *The following Letter to the Editor was received by the George Wright Society FORUM, in response to the "Review and Recommendations on Animal Problems and Related Management Needs in Units of the National Park System," by Durward L. Allen, Larry Erickson, E. Raymond Hall, and Walter M. Schirra, which appeared in the Autumn 1981 issue of FORUM. It is run here because of its pertinence to National Park management and in the hope that it will elicit further comment.*

To the Editor:

In the autumn issue of *The George Wright Forum*, Allen *et al.* (1981), p. 27-28, state that "even the most superficial review of animal problems in the parks reveals that overpopulations are at the root of many difficulties." They further suggested that perhaps deputized hunting, "to take surplus big game within national parks will need to have greater consideration in the future." Although I am confident that the authors were not proposing that ungulate management in national parks be based on superficial analyses, I believe that they understate the complexity of the issue.

The term "overpopulation" implies that there are too many individuals of a given species in a given locality. However, determination of acceptable population sizes or densities is difficult, except in cases of exotic animals in national parks, where even one individual represents an overpopulation. Even that policy is based on a social judgment and is subject to change with changing societal values.

Identification of overpopulations of native animals is considerably more complex. Allen *et al.* (1981) felt that overpopulations existed when *man-caused* habitat changes or other influences caused a species to increase to a level which was destructive of its food supply or damaging to pristine plant and animal communities. If it were easy to identify man-cause changes and to document damage to food supply and pristine ecosystems then animal management decisions would be fairly simple. However, identifying those impacts usually is difficult.

An important problem is our lack of understanding of primeval systems. In order to measure ecological change caused by man, we must understand how the system functioned prior to his arrival. Because we were not present to describe those environments, we must rely on historical accounts and current studies of contemporary habitats and wildlife populations that usually are conducted over a relatively short time span. As one would expect, this frequently results in oversimplification, conflicting opinions, and perhaps even misinterpretations and erroneous conclusions.

As a result, our understanding of processes by which wildlife populations were regulated primevally is fairly rudimentary. With regard to ungulates there are basically two perspectives; one emphasizes the role of predation and the other suggests that ungulate-habitat relationships are most important. It seems unlikely, however, that a single factor is involved in natural regulation of ungulates.

Peek, (1980, 1981) and Caughley (1981) provide excellent discussions of those two approaches. Briefly, predation hypotheses emphasize the importance of predators in limiting prey populations, both by direct reduction of numbers and impacts on behavior and distribution. Habitat-ungulate hypotheses postulate that ungulate populations were limited principally by availability of forage. Much of the latter approach has been derived from observations of sudden increases or irruptions of ungulates following improvement of habitat (i.e. by fire) or their introduction to previously unoccupied areas. Caughley (1979) considered irruption to be a basic pattern of population growth for ungulates, with establishment of new herbivore-plant equilibria following peak populations.

Clearly the park manager is faced with a dilemma. If extirpated predators were the principal factors limiting ungulate populations, hunting or direct reduction could be appropriate. On the other hand, if irruptive growth of ungulates is natural, high densities would not necessarily represent overpopulation.

Even if an unnatural increase in a population occurred, and reduction was desirable, we still must determine an appropriate population density. In other words, a "carrying capacity" must be established. This term requires careful definition. Caughley (1979) pointed out that it has been used commonly to denote a density of animals that provides a maximum sustained yield. Caughley calls this density "economic carrying capacity," in contrast to "ecological carrying capacity," which typifies an unharvested equilibrium.

Populations managed at economic carrying capacity typically will be at low to moderate densities, have high reproductive and survival rates, and individuals will be in relatively good physiological condition. The converse of these will be true for populations at ecological carrying capacity.

Neither of those two versions of carrying capacity is right or wrong. Rather, the two reflect differences in management ojectives; it is critical that park managers know the difference between them. State game agencies most often will manage for economic carrying capacity, while the National Park Service appropriately should manage for ecological carrying capacity. Population densities that would be considered to be overpopulations on non-park lands may be perfectly natural in a national park.

Managers also should recognize that reduction of population densities will result in increased productivity and survival, thus making control even more difficult. This is precisely the technique that is used to manage ungulate populations for maximum sustained yield. Therefore, controls such as hunting would be required indefinitely. Not only will control change the demography and dynamics of the ungulate population, but behavior and distribution also will be influenced.

Thus, in view of our incomplete understanding of natural regulation, any decision to hunt or control native populations should be critically scrutinized and based on specific scientific research. This research should focus on the mechanisms of population regulation for the species and population in question. Superficial analyses may suggest that surplus individuals should be removed, when in fact populations are simply at ecological carrying capacity. On the other hand, increased knowledge of natural regulation would allow early identification of man-caused changes and permit timely implementation of management programs to either control or augment populations.

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To the Editor:

I am writing about program priorities: the urgent, the critical, the routine.

Considerable emphasis has been placed on the establishment of park, Regional, and Servicewide priorities to cover diverse projects, ranging from construction, Park Rehabilitation and Improvement Program (PRIP), park planning, research, resource management, and any other task that can be ranked numerically. Priorities can be an extremely useful tool in making "either/or" decisions in times of limited funds, such as funding one project and deferring another, or emphasizing one program over another. Health, life and safety issues of PRIP make up a good example of the latter. However, priorities are not a substitute for, nor should they override, common sense. This is especially true in resource management.

Several schemes have been developed to rank projects in terms of a variety of legislative, ecological, or other pertinent factors with a goal of identifying those projects which are most critical and urgent. These, of course, are the projects given the highest priority ratings. As a general rule, high priority projects also are the most costly. The implication that the Service should address only the highest priority resource projects is myopic and can only lead to the degradation of cultural and natural resources. Nipping problems in the bud stage, (i.e., low priority), is sounder and more efficient than waiting for them to bloom into unmanageable crises. An old Service motto for cultural resources reflected this philosophy: "It's better to maintain than repair; it's better to repair than restore; it's better to restore than reconstruct."

I haven't seen or heard that saying for a number of years, but despite the fact that it appears in conflict with our current priority ranking of cultural resource

problems, in my opinion it still is valid. We should not have to wait until a structure is in a state of disrepair to take a positive corrective action.

Nor should we wait until natural resource management problems become critical. The timely removal of several leafy spurge plants – let's say priority problem 36 in a park's resource management plan – when the spurge has covered and perhaps irreversibly damaged several square miles of park land. The ecological soundness and cost effectiveness of the former approach is self-evident.

Priorities may have different meanings at different levels of the organization. At the WASO level, apparently, they are extremely important. At the field level, however, priorities for resource management activities may range from relatively small importance to none. The field manager is faced with from one to several dozen resource management tasks that *must be accomplished* to fulfill his/her responsibilities. Which is No. 1 or which is No. 36 is immaterial. Completing the *total band* of activities is the goal. Recent correspondence from WASO believes only the highest priority projects are to be addressed; if this is so, it is clear we do not fully understand the art and science of park management. Resource management is much more than properly filled out forms and formats; it's actually using a shovel or other appropriate tool to accomplish the project objective. The relative priorities assigned to projects are never as important as maintaining the integrity of park environments and resources.

Of course, attacking a resource problem without adequate knowledge of the problem and proposed treatment can be as disastrous as doing nothing. As has been illustrated time and time again, exotic plants cannot be effectively controlled by the use of herbicides, which merely perpetuate disturbed site conditions under which exotics can flourish. If unsure, ask: Can the project be deferred without damage to the resource or future increased costs to the park? Is there a cost-effective, workable solution to the problem? The answer to the latter often is unknown, especially in the lower priority projects; i.e., the magnitude of and solutions to lower priority problems generally are undetermined.

Perhaps a distinction should be drawn between those few Servicewide Significant Resource Problems (SRP's) and the routine, but nonetheless essential, intrapark resource management actions. The former can be prioritized, but it is relatively meaningless to prioritize tasks which must be accomplished regardless of their relative rank. Also, annual adjustments in project priorities often are necessary. For instance, bison reductions in Wind Cave NP and other northern Great Plains parks normally occur on alternate years. In those years when reduction of the population is necessary, of course, the priority and cost of bison management are higher than in years of population growth.

If we must have priorities in resources management, the system should be designed to aid, rather than hinder, the Superintendent in the acquisition of knowledge and in carrying out the total array of his management responsibilities.

N.J. Reid, Chief Scientist
Rocky Mountain Region

superintendents' corner

Editor's Note: *Robert C. Haraden, superintendent of Glacier NP, this spring presented a paper entitled "Practical Considerations in Management of a Biosphere Reserve" to the India-U.S. Workshop on Biosphere Reserves and Conservation of Biological Diversity in Bangalore, India. Since the paper was subtitled "A Manager's Perspective," we thought it appropriate to present excerpts in the Superintendent's Corner.*

The designation of Glacier National Park as an International Biosphere Reserve has added a new dimension to park management. Attention has been drawn to scientific and educational values along with the very practical usefulness of preserving genetic diversity. It further enhances our efforts to generate greater interest in research values of parks.

Part of our interpretive effort tells the story of Glacier as a park that has worldwide importance. We embrace the idea of preservation of this mountain environment for international research, education, and training, while at the same time providing for visitor enjoyment.

Out of the *1980 Report to the Congress* on internal and external threats to the parks came the determination that Glacier was the most threatened park in the system. This may have been a little misleading, since Glacier did a very thorough job of identifying its threats while some other areas treated the assignment less seriously.

Nonetheless, serious external threats to the integrity of Glacier exist. They range from proposed extensive coal strip mining within eight miles of the park boundary in Canada and within drainages that come into the park to fluouride emissions (now being mitigated) from an aluminum plant within six miles of the park, to logging, oil and gas exploration, homesite development, and road construction on adjacent state and U.S. Forest lands and trespass livestock grazing along the Reservation boundary.

Individually, these impacts are important because of their direct effects on the park; more important is their cumulative effect – on the park and on the wildlife that ranges in and out of the park, especially the grizzly bear, bald eagle, and northern gray wolf. These problems arise from, and are complicated by, the fact that Glacier's boundaries were established on political rather than ecological lines. This is true of most U.S. National Parks.

The State of the Parks report has drawn attention to the need for additional research at Glacier and some research funding has been redirected, especially toward basic inventories and baseline monitoring. The Park's Resource Management Plan (RMP), designed to deal with some of these issues, has its roots in a master plan, which sets this goal for natural resource management:

"Park ecosystems will be managed to protect, preserve, or restore where necessary, natural biotic relationships for the scenic, educational, and scientific benefit of the visitor."

Areas of attention include, but are not limited to (1) protection and restoration of the natural vegetative, wildlife, and aquatic systems; (2) re-establishment of the natural role of fire; (3) evaluation of external sources of resource damage; (4) encouragement of natural science research to provide scientific criteria for conservation, management, and/or restoration of the natural ecosystems; and (5) use of public input in making management decisions.

The 1960s marked a major change in the direction of park research. Management began to recognize the need for credible information on which natural resource decisions could be made. An agency funding program was implemented and scientists were put on the park staff to address pressing needs. National environmental legislation in the 1970s strengthened and supported park research.

Today's program is dramatically different from just a decade ago. Staff scientists conduct studies in con-

St. Mary Lake Narrows *– Glacier NP*

cert with management requirements. University contracts and interagency agreements fill the voids. Scientific research demands are increasing and an expanding data base is helping us protect and manage park resources.

Glacier National Park was established as an International Biosphere Reserve in 1976 . . . recognizing it as a representative area for its conifer forest and alpine tundra and its designated responsibility to preserve genetic integrity in the plant and animal communities.

We are providing specific Man and the Biosphere (MAB) exhibits at the park and weaving MAB into our interpretive programs and environmental study areas, into our talks to service clubs and other outside speaking engagements, and into our information releases to the various media outlets.

A severe lack of public knowledge about MAB exists at present, but as we tell the story, we heighten public awareness of the global significance of national parks and equivalent reserves. Our June (1982) symposium at Glacier, in concert with the Canadian Waterton Lakes National Park, addresses management of the parks in relationship to their adjacent lands. It examines the issues and problems in the context of research, monitoring, and education, and seeks to identify research and management strategies that might contribute to improved administration and use of complexes of multipurpose and multiagency lands in the future.

The introduction of exotic fish into the park between 1912 and 1972, the recent detection of measurable degrees of acid precipitation in Glacier NP, and other examples of degrading changes, all draw attention to the importance of MAB-oriented research. The research cannot be accomplished too fast. Managers cannot always wait for results; they are liable to find themselves dealing with multiple environmental threats before all the information is at hand.

To gain the support for such research, we need public understanding . . . good brochures, technical aids such as slide/tape programs, video presentations and other good exhibitry.

While national parks are ideal barometers of the world's environmental condition, they depend for their support on human use. For this reason, some of our research needs to be directed toward people management. For me, as a manager, this is as important as research directed toward the grizzly bear. One is unalterably tied to the other, just as is everything else in the universe.

Park interpreters play a key part in explaining the role of resource management and research to the public. We may not be able to save Glacier NP as we know it today unless there is a change in the attitude of people about how we manage the lands surrounding the park. Such a change would constitute a new land management ethic. I would hope that the research, education, training, and public information resulting from the fact that Glacier is an International Biosphere Reserve, would lead toward public support for that new ethic.

Robert C. Haraden, Superintendent
Glacier National Park

Information Crossfile

Harold Morowitz, in his February *Science 82* column "Of Minds and Molecules," describes an interview he had as a young scientist, in which he tried to explain what he was doing in terms of "adenosine triphosphate" and similarly arcane language. At every turn the reporter balked "and we had to go back to square one." The article that finally appeared was garbled and gave a confused account of the research in progress. "The troubling issue persisting over the years," Morowitz writes, "is that one of the great intellectual triumphs of all time is written in tongue-twisting polysyllabic words such as nicotinamide-adenine-dinucleotide-phosphate. How is one to tell the story of this important achievement in biochemistry to a general public unfamiliar with such language? One of the most significant advances in understanding the nature of life remains unknown to most people because it is inseparable from very long words that intimidate the uninitiated and keep them from insights that hold a wide range of unexplored implications."

Tincke Bodde of *BioScience* has related thoughts on science information transfer. In the March issue he quotes James Grunig, professor of journalism at the University of Maryland, on the subject. The greatest contribution a scientist can make toward an accurate, informative news story about his work, Grunig believes, is "framing the story for the writer, putting his work into some kind of context – telling the writer, for example, why he or she wanted to do the research, what the problem was that he was trying to solve, or what the importance is of his research, basic or applied, to science or to practical life situations." Most scientists assume, rightly or wrongly, Bodde thinks, that the writer knows these details. A word to wise scientists is sufficient.

⁂

One of the papers given at the Third International Conference on State-of-the-Art in Ecological Modeling, held May 24-28 at Fort Collins, explores the economic and energetic measurement methods for obtaining the relative values of natural vs. mechanical systems for solving environmental problems. Prepared by Ane D. Merriam and Shirley P. Burggraf, the paper is a model for determining "appropriateness" in using environmental systems in appropriate technology applications. Both energy and economic analysis are applied in two case studies, and the political feasibility factor also is taken into account. Merriam is director of Water Resources, Institute of Science and Public Affairs, Florida State University, 361 Bellamy Building, Tallahassee, FL 32306; Burggraf is professor of economics, Florida A&M University, 301 Lee Hall, Tallahassee, FL 32307.

⁂

The current issue of *Trends,* Vol. 19, No. 1, is devoted to natural resource management. The issue addresses the latest developments in fire management, integrated pest management, endangered species, wildlife populations, and mineral management. Also included are articles on resource management plans, natural resource management training, the complexities of resource management in the parks, and a manager's perspective of natural resource management.

⁂

Science Record, the Oregon State University College of Science bulletin, carries word in its Spring 1982 issue that the entire collection of imagery taken by NASA's Landsat I – the first Earth Resources Technology Satellite – is now the property of the OSU Department of Geography. The collection, conservatively estimated at more than $7 million in worth, consists of more than 700,000 film negatives of earth's surface taken between 1972 and 1978. The donation to OSU was made by the U.S. Department of Agriculture.

The smaller collections of negatives taken after 1978 by Landsat II and III are being shared by the University of Arizona, the University of California at Santa Barbara, and the University of Wisconsin at Milwaukee. All four universities have agreed to code and classify the imagery in the same manner, to simplify interinstitutional exchanges.

⁂

"America's National Parks: A Heritage in Jeopardy," is the title of a five-part series that ran, beginning June 14, 1982, in *The Christian Science Monitor.* Written by Robert Cahn, who won a Pulitzer Prize 14 years ago for a similar series entitled "Will Success Spoil the National Parks," the current series takes a look at the new concerns – external threats, untraditional additions to the System, and political and budgetary restraints that "often work against parks getting the expert help needed to care for their resources adequately."

⁂

Midwest Region NPS scientists are keeping current with literature through weekly circulations of "Current Contents." They receive weekly editions in the following areas: (1) agriculture, biology and environmental science; (2) physical, chemical and earth sciences.

Each edition lists the table of contents from recently published scientific journals in these areas. Author addresses also are given so that reprints can be ordered. The scientists, especially those far from libraries, have found "Current Contents" to be a valuable tool. Once each issue circulates through the Region (about 4-5 weeks), it comes back to the Regional Office and then is routed to Alaska Regional Office, Western Regional Office, and Mid-Atlantic Regional Office. If anyone else is interested in looking at these "spent" issues, please contact Gary Larson (Midwest Regional Office, 1709 Jackson Street, Omaha, NE 68102) and your name will be added to the routing slip.

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A University of Oregon researcher and her colleagues have found fossil evidence for plant life existing as long as 475 million years ago in Libyan rock samples recovered from oil-drilling explorations. The dating, by UO biologist and geologist Jane Gray and others, appears to push back by about 75 million years the earliest known time plant life established itself on land, beyond datings of previous finds in the North Atlantic Region. Results of Gray's latest work – done in collaboration with geologist Arthur Boucourt of Oregon State University and Dominique Massa, a geologist with the French petroleum firm Compagnie Francaise des Petroles – are reported in the April 1982 issue of *Geology.* The evidence is in the form of "cuticle-like" sheets of cells and microscopic spores of some form of land plant that once existed near ancient ocean shorelines – now part of inland basins isolated from the Mediterranean Sea in western and southern Libya.

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The Seattle monthly alert *Westfornet* (Western Forest Information Network) for May contains news of:

An article by R.F. Strayer and M. Alexander in Vol. 10 No. 4 (October-December 1981) *Journal of Environmental Quality,* p. 460-65, that deals with the effects of simulated acid rain on glucose mineralization and some physico-chemical properties of forest soils.

A piece by Max W. McFadden (et al) on integrated pest management in China's forests, in the *Journal of Forestry,* Vol. 79 No. 11 (November 1981), p. 722-26.

An article by David J. Parsons in *Madrona,* Vol. 28 No. 3 (July 1981) on the historical role of fire in the foothill communities of Sequoia National Park.

A position paper on managment and protection of western riparian stream ecosystems by the American Fisheries Society, Western Division, Riparian Habitat Committee of Tualatin, OR.

⁂

***Science 82,* in its June issue,** describes the efforts of three Woods Hole Oceanographic Institution biologists to assess the role of ballast tank water in accelerating the spread around the world of fish, plankton, shrimp, crabs, worms, and other saltwater creatures. Ballast tank hitchhikers recorded within 10 minutes of the opening of the ballast tank hatch of a ship in Delaware Bay included sticklebacks picked up in the Weser River in West Germany 12 days earlier, plus several kinds of opossum shrimp, copepods, bristle worms, and lots of phytoplankton. A few accidental introductions – like the Atlantic soft-shell crab *(Mya arenaria)* and the Japanese cockle *(Tapes japonica)* – both introduced on the shells of oysters brought for cultivation to the west coast of North America – have been economically beneficial. But many of the accidental introductions have followed the usual pattern of exotics, outcompeting native species and creating general economic and environmental headaches.

⁂

The Crosscurrents section of June's *Science 82* provides this issue's laugh. It concerns "The Name Game" *a la* Carolus Linnaeus, who ordained in 1753 that all plants and animals should have a generic and a specific name, preferably in a language approximating Latin or Greek. When a colleague named Evans sent Arnold Menke of USDA's Systematic Entomology Lab two wasp specimens from Australia, Menke looked at them and exclaimed "Aha!" He then announced the species in a paper entitled *"Aha,* a new genus of Australian Sphecidae." The first he named *Aha evansi,* the second *Aha ha.* "If the gods (and Evans) are kind enough to provide him with such an opportunity again," the item reads, "Menke now says he will name the new genus *Ohno,* and will report the discovery in a paper entitled *"Ohno,* another new genus of Australian Sphecidae."

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The Summer 1982 issue of *Forum* contains an article by Jim Bennett of the NPS Air Quality Division, describing the development of a computerized floras (systematic lists of the plants of an area) for all natural area parks in the National Park System. The project, kept deliberately small for purposes of economy and efficiency, was begun in 1982 and is expected to continue in Fiscal Year 1983. Gary Waggoner of the Denver Service Center is directing the entry of the floras, checking the synonomy, and collecting some of the floras. Eventually, it is planned to make the data base accessible to users outside the Air Quality Division, Bennett says.

Ecology Review Lauds Scientific Monographs

Words of praise for the National Park Service's Scientific Monograph Series appeared in *Ecology* (Vol. 63, No. 2, p. 601-2) from the pen of Norman L. Christensen, department of botany, Duke University. Some excerpts:

"Several volumes deal with the ecology of large mammals and the importance of National Parks as refuges for such beasts. The first volume on the bison in Yellowstone National Park (by M. Meagher) is a data-rich treatment of the factors controlling their populations. It also provides a detailed description of the historical changes in bison populations in Yellowstone. The biology of the grizzly bear in Mount McKinley National Park is the topic of the fourteenth number in the series. This volume represents the life work of Adolph Murie and deals primarily with the habits and behavior of the grizzlies. Written almost in the style of a diary, it is a beautiful glimpse into the wonderings and wanderings of a superb naturalist. Unlike other volumes, we are not confronted here (for better or worse) with tables or statistics. To quote Murie, 'I have, I think, avoided the ecologists jargon, the scientific phrases so frequently created by ecologists and animal behaviorists to make simple facts sound profound and impressive.' Nonetheless, we are convinced by this volume that careful empirical observations, even if expressed in the common tongue, still are of great value in ecology.

"Numbers 8 and 12 *(Ecology of the Saguaro* by W. F. Steenbergh and C.H. Lowe and *Giant Sequoia Ecology* by H.T. Harvey, H.S. Shellhammer and R.E. Stecker) are detailed and comprehensive accounts of the ecology of single species. . . . The basic ecological information provided more than justifies their existence. However, I found the final chapters in each volume on management problems and strategies to be equally informative. Both volumes provide ample proof of the essential connections between ecological studies and sound management policy.

". . . Four volumes together form one of the most comprehensive treatments I know of on the ecology of Atlantic Coast barrier islands. Number 7 (by H. Art) is an ecosystem-level study of the sunken forest on the Fire Island National Seashore. Numbers 6 (by S. Au) and 9 (by P. and M. Godfrey) deal with the history and dynamics of barrier island ecosystems south of Cape Hatteras. Number 3 (by A.S. Johnson, H.O. Hillstead, S.F. and G.F. Shanholtzer) is a survey of the variety of ecosystems associated with barrier islands along the coast of Georgia. This volume treats in greater detail than the other three the faunal ecology of these ecosystems, including invertebrates."

In summation of the series review, Christensen asks a question and then provides his own answer.

"Is the publication of such a monograph series justified in an age of competing needs and budget constraints? After reading these volumes, I answer with an emphatic yes. These are not 'coffee table' picture books and, in fact, may seem pretty dull reading to the average park visitor. However, each book gives a very factual look at interesting organisms and unique ecosystems, and makes clear the problems involved in integrating this information into policy decisions in the context of the multiple goals of the Park Service. For several years I have used two of the barrier island volumes as case history studies in my plant ecology course. Because they are less austere than scientific papers, students find them interesting to read, yet each one explicitly outlines methods, results, and conclusions in a very scientific style. Their modest cost makes them attractive for this purpose. It would be a great loss if the National Parks were not major laboratories for ecological research. These volumes represent an appropriate vehicle for synthesis of that research and deserve much more attention than they have yet received.

Biological Studies and Materials Comparisons on a Puget Sound Artificial Reef

By Jeffrey C. Laufle

For centuries, fishermen have known the value of artificial reefs. These structures, when placed on otherwise barren lake or ocean bottoms, attract and concentrate fishes. Several scientific studies have been done to determine how fishes use artificial reefs. It has become apparent that both food and shelter benefits are derived by the fishes.

The Washington Department of Fisheries (WDF) began a program of artificial reef installation in Puget Sound in the mid-70s, with the goal of enhancing sport fishing. So far, four reefs have been constructed, and more are planned. Two are associated with public fishing piers, and two are off-islands and aimed at boat anglers.

The reefs were constructed of concrete rubble, bundled automobile tires, or both. The WDF contracted with the Washington Cooperative Fishery Research Unit at the University of Washington to determine which was the more effective material from biological and other standpoints. The study site was Blake Island, near Seattle in Puget Sound, where one of the boat-angling reefs had been built with both tires and rubble. The natural bottom there is a mix of sand, gravel and cobble. The tires were in a configuration called "triads" and about 50 of these units were placed in groups of around five to eight, both on and off a large area of previously placed concrete rubble. These materials were at about 45 to 60 feet depth (mean lower low water), although a smaller pile of concrete rubble lay at a depth of 85 to 95 feet.

We established six experimental survey areas: three on and three off the rubble. The areas (each 36 m^2) contained either three triads bundled together, two separated triads, or no triads for a control. In addition, the entire deep rubble reef (about 464 m^2) was used as a seventh survey area, and a kelp bed transect inshore was an eighth. These areas were censused for fishes, using SCUBA, once each month during the day for 15 months, and once a month at night for 12 months, starting in fall 1980.

All fishes that we saw in an area were identified, counted, and their lengths estimated with the aid of ruled edges on plastic recording slates. From the length estimates, we could estimate weights later with length-weight equations already available. Fishes that were inside, under, touching, or otherwise positioned very close to the tires were defined as associated, for this study.

We found 24 species of fishes in all the study areas combined. For the individual habitats the totals ranged from six species (for the bare natural substrate) to 12 to 14 on the artificial habitats. The dominant family was the *Embiotocidae,* or surfperches. The four species representing this family were the only schooling species in the study areas. The striped seaperch *(Embiotoca lateralis)* was often the most important of any species, in terms of numbers and frequency of occurrence, and sometimes biomass. Rockfish (family Scorpaenidae, *Sebastes* spp.) were the second most common and abundant group, and were represented by three species. Copper rockfish *(Sebastes caurinus)* were the most important of these.

Although schooling species of rockfish are found in Puget Sound, we saw none. The Hexagrammidae, or greenlings, and the Cottidae, or sculpins, were the two remaining families we saw with any regularity. Very small (2-5 cm.) sculpins were present on all habitats, but they were difficult to detect and were ignored because of the large effort which would have been required to census them. Similar patterns of species groupings occurred on the various artificial habitats. Although no statistical similarity occurred between assemblages on artificial and natural habitats, neither were there any radical differences between these two habitat types.

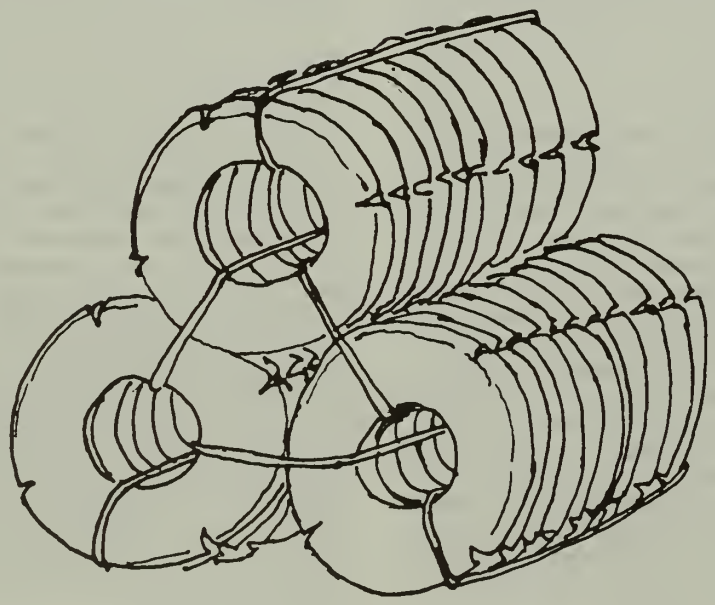
We found that density and biomass of fishes were much higher on the artificial habitats than on the natural habitats (including the kelp bed). That the reef should concentrate fishes was not surprising, since this was the premise behind its installation. It seemed puzzling, though, that fishes should have been so sparse in the kelp bed. Kelp provides another form of structure, and such areas are well-known to sport fishermen for their productiveness. Part of the explanation is that the kelp forest virtually disappeared in the winter, but even in summer the fishes simply were not found there in any great numbers.

Striped seaperch (Embiotoca lateralis) *near large scrap manhole box forming part of concrete rubble reef at Blake Island. Encrusting organisms on concrete are primarily barnacles and tubeworms, which build calcareous tubes.*

Of the three triad arrangements in the experimental areas, including the control areas with no triads, the three bundled triads were somewhat better at attracting fishes than the others. Two factors qualified this result. First, the separated triads on the natural substrate moved in the tidal current, They remained connected by a length of rope, but when they were relocated, they had accumulated a layer of sand, and appeared to have dug into the surrounding sediment. Very few fishes were associated with them until much later in the study; we think that this sort of disturbance may be detrimental to resident fish communities.

A second qualification on the superior attractiveness of the bundled triads was that they were not as consistent for fishes on the rubble as on the natural substrate. The fish seemed to orient more toward the general vertical relief than they did to one material or the other. The schooling species (the surfperches) moved around the entire reef in small or large aggregations. They foraged for small crustaceans in the algae growing on the different materials, as well as on the sand/cobble substrate. The rockfish could be found near the bottom, either associated with the tires or not. It was difficult to predict where they would occur. Much the same was true of the other species of bottomfish on the reef.

Fishes oriented to triads on natural sand/cobble substrate over a broader area than they did to the triads on the concrete rubble. On the natural substrate, the triads were the only nearby relief, whereas those on the concrete rubble had the rubble itself sur-



Triad unit, *made of automobile tires tied together with polypropylene line and slit to allow air to escape. Triads were either further bundled together or kept separated for the Blake Island artificial reef study.*

rounding them. Fishes might be associated with either tires or concrete, but the important variable was the veritcal relief.

It was apparent, then, that most fish species were not choosing between the two types of material. The exception was the lingcod *(Ophiodon elongatus),* not a cod at all, but a large, economically important demersal predator of the family *Hexagrammidae.* This species spawns in the wintertime, with the male setting up a territory where the female deposits an approximately basketball-sized egg mass. The best areas for spawning appear to be those with good currents for ventilation and where there are crevices in which to lodge the egg mass. The male then guards the mass over a six to seven week incubation time.

Lingcod spawned on the concrete rubble reef, but never on the tires. There are moderately strong currents at the site, and plenty of crevices among the rubble. We monitored the nests in the winter of 1981 and part of the winter of 1982. In 1982 we found that three nesting sites marked in 1981 were being used again, confirming observations of others in northern Puget Sound on the recurring use by lingcod of natural substrates.

These results are significant for several reasons. First, the lingcod made a choice between materials, spawning on rubble exclusively. Second, outside of current WDF research, we know of no documentation of lingcod spawning on artificial reefs. Spawning has been reported on breakwaters, but the material was natural quarry rock. Third, egg masses observed on the deep rubble, at 89 and 95 feet, represent the deepest documented spawning thus far. Fourth, and perhaps of greatest importance, fishery statistics have indicated a serious decline in lingcod stocks in Puget Sound, prompting a total moratorium by the WDF on sport and commercial lingcod fishing in the south and central Sound, starting in 1978. The WDF has had a multifaceted program of lingcod research and enhancement in operation, and while artificial reefs are a separate program, we see great potential for their use in resorting lingcod populations.

Other factors in the analysis are cost and stability. Based on figures made available by the WDF, who were responsible for installation of the reefs, the concrete was much cheaper than were the tires per unit of bottom area covered. Costs vary depending on the scale of the operation, whether materials are donated or must be paid for, and whether they must be barged any distance. One large reef built of tires by the WDF off a mainland shore in Puget Sound was cheaper per unit area than the tires at the Blake Island site, but still somewhat more expensive than concrete rubble. In addition, the tires were less stable in currents than was the concrete, and required careful anchoring and several man-hours of diving to install. The concrete needed only to be transported to the site and unloaded from a bottom-dumping barge.

So we have the cost and stability aspects, and apparent lack of preference by fishes for either material, with the important exception that lingcod chose the rubble over the tires for spawning. The main result from additional monitoring of invertebrate and algal populations on the reef is that a food web in probably adequately supported on both tires and concrete. Thus, we came to the conclusion that of the two materials tested, concrete is probably better for this environment.

The work reported here is only a beginning, however. The Japanese and Taiwanese have advanced artificial reef technology well beyond work in this country, with large scale operations, and examination of chemical, geological, and hydraulic factors. Patented designs are being marketed, and we have much to learn from their efforts. A major obstacle is the lack of good translations of reports.

It may be some time before we reach the level of sophistication the Asians have attained in this field. As long as we use scrap materials to build our own reefs, it would be appropriate to caution against planning a reef whenever we need to dispose of nondegradable waste such as tires. Artificial reefs can be good avenues by which to do this, but a careful approach and wise planning cannot be overemphasized.

Park managers who wish to create new recreational areas using this technique obviously need to consider several factors, not all of which have been discussed here. The reef we studied was created for fishing, and not SCUBA diving, although the latter is apparently going on there. However, since spearfishing, for example, is so efficient, it would seem better to design an underwater park for nonconsumptive uses such as photography. To this end a natural area might be better than an artificial reef.

Laufle, a master's research assistant, works out of the University of Washington Fishery Research Unit.

Male lingcod (Ophiodon elongatus) *guarding egg mass (right), which has been deposited under concrete slab at Blake Island artificial reef. Fish is about 60 cm in length; egg mass is about 25-30 cm in diameter.*

Quillback rockfish (Sebastes maliger, *top center), and copper rockfish* (S. caurinus, *center), associated with tire unit at Blake Island artificial reef.*

Ecological Systems Analysis Draws Global Group

By William H. West

The Third International Conference on State of the Art in Ecological Modeling was held at Colorado State University in Fort Collins, May 24-28, sponsored by the International Society for Ecological Modeling (ISEM) in cooperation with the National Park Service Water Resources Laboratory and hosted by the CSU Natural Resource Ecology Laboratory. Scientists and land managers from Egypt, France, Austria, New Zealand, Denmark, Argentina, and The Netherlands as well as the United States, Canada, and Mexico attended the five-day conference to advance the development of ecological and environmental modeling.

The conference had as specific objectives: 1) to provide the first forum in North America for the international exchange of research results and applications in ecological modeling; 2) to expand the subject matter of the first and second conferences; 3) to provide more focus on specific problems in systems ecology and their solution by employing ecological modeling for managing the environment; and 4) to create a North American Chapter of ISEM to strengthen the international communication and interchange in this subject area. In pursuit of these objectives, papers were presented during technical sessions in five general areas: Energy Development, Theory and Methods, Water Resources, Animal Life, and Land Resources.

Papers presented in each of the five general areas ranged from theoretical, to applied, to aids and techniques useful in systems ecology. Many of the papers presented in the methods and theory session dealt with the problem of quantifying the interactions between different elements of an ecosystem. Questions were raised concerning the magnitude of direct versus indirect effects and how to determine these interactions. Many new and varied approaches to these problems were presented and while the proposed solutions are still highly theoretical, their applications to practical problems can be plainly seen.

Among the papers addressing today's practical problems were applied models in such areas as Spruce budworm outbreak and control, determination of optimal resource sampling, the effects of cultivation on crop yields, and recreation carrying capacity of ecosystems. Each of these models, and many more presented, was designed with the manager in mind. Limited data inputs and conversational interactive programs were just two of the methods used to make ecological modeling more responsive to the land manager.

New techniques, and old techniques newly discovered, were presented in papers to aid the modeler. In many instances, the procedures presented allow the modeler to better provide for the needs of the manager. Papers in the areas of curve fitting, modular programming, parameter estimation, and sensitivity analysis provide the systems ecologist with the tools necessary to better model an ecosystem and to evaluate the results of their modeling effort. These procedures, in many cases, provide the modeler with the simplifications needed to convert ecological modeling from primarily a research tool to that of a management tool.

The closing session consisted of state-of-the-art reports in each of the five general areas with summaries of the previous sessions and an opening of the meeting to comments and discussions from the floor. In the course of the discussion, a clear consensus of the state of the art in ecological modeling emerged. It was widely accepted that the art is at a very primitive state. The field has made some strong advances over the last few years, as demonstrated by the quality of papers presented, but is not currently at the point where it can truly be called a discipline or concentration. The need was expressed by some for a unified approach to quickly advance the modeling field beyond its current condition. An opposing view was expressed by those who felt that because ecological modeling was still in its infancy it was premature to develop a unified approach. It was apparent that ecological modeling will evolve at its own pace and explore all avenues of thought.

Closely linked with the unified approach to ecological modeling was the concept of a global ecosystem theory. Although generally believed to be a decade away, and in some aspects a generation away, it was strongly felt that systems ecology provided the best opportunity for developing a general ecosystem theory. A global ecosystem theory advanced through systems ecology could remove much of the ambiguity currently faced in resource management, benefiting both the researcher and manager.

One concept universally expressed was the need for the modeler to become more in tune with the needs of the manager. To accomplish this the manager must be brought into the modeling process and made aware of the benefits and limitations of ecological modeling. The modeler must design programs with the user in mind through such techniques as limited data inputs, user friendly interactive programs, and modular programming. Additionally, the systems ecologist must gain a better understanding of the needs of the manager by better communications with management and through the concept of a modeler manager dual training.

In general, the third international conference on State of the Art in Ecological Modeling was a success. Through the exchange of ideas and the discussion of new approaches the field of systems ecology was advanced. The concepts presented and the courses plotted will provide resource managers with new tools, and a clearer understanding of the ecosystem, both now and in the future. Through meetings such as this the field of systems ecology will become an ever-increasing segment of ecosystem research and management. Those interested in a copy of the conference proceedings, which include all papers and the five state-of-the-art summaries, may write to:

ISEM
Langkaer Vaenge 9
DK-3500 Vaerloese (Copenhagen), Denmark

West is with the BLM Division of Resource Systems, stationed at the Denver Federal Center.

***Editor's Note:** A Pacific Northwest modeling project, described in the most recent OSU/CPSU Annual Report (for 1981), is reported here.*

Models to simulate ecological changes in Mount Rainier, Olympic, and North Cascades NPs have been developed for NPS by Jerry Franklin of the U.S. Forest Service, and Mark Harmon of the Oregon State University Department of Forest Science.

Study objectives were: (1) to develop a computer model that will simulate the birth, growth and death of trees in west slope forests of the Pacific Northwest; (2) to verify the model using a known data set from H.J. Andrews Experimental Forest and produce a document explaining model structure, limitations, and potential uses; (3) to use the model for comparing effects of clear-cutting, blowdown, and fire disturbance on succession of Douglas-fir forests in Olympic NP; and (4) to incorporate the influence of elk browsing and nurse-logs into the model and assess the impact of these variables.

The model has been constructed and verified, using the H.J. Andrews data set. A paper has been prepared explaining the structure of the model and potential uses, and a manuscript of the model documentation, by Dr. V.D. Adams, describes the subroutines used to stock, grow, kill, and disturb the simulated forest. The rationale for the equation forms, model results and validation also are presented, to give potential users of the model confidence in the model's ability to simulate changes in forest structure over time.

The model now is being used to test effects of clear-cutting, fire, and wind-throw on stand structure. Modeling effects are being combined with research conducted by James Agee (PNR research biologist) in Olympic NP. The influence of elk on structure of sitka spruce-western hemlock was investigated in 1981 via the model and has been submitted for publication to *Northwest Science*.

The study's basic conclusion was that fluctuation in elk populations during the last 150 years have had little obvious effect on forest structure. Preliminary field work on development of trees on nurse-logs was completed and more extensive work is planned for summer 1982. The goal is to determine probability of a seedling growing on a log becoming a canopy tree.

In another spase of research on the role of nurse-logs, a set of experiments has been undertaken in the Hoh River Valley to determine factors that contribute to heavy use of logs as seed beds. The experiments will test the effect of seed predation, competition with other ground cover (e.g. mosses), flooding and soil pathogens. These experiments will be completed this summer.

Composting: Solve a Problem And Create a Useful Product

By J.C. Patterson and J.R. Short

The Chesapeake and Ohio Canal NHP parallels the Potomac River for approximately 185 miles, from Washington, D.C., to Cumberland, MD. Built between 1828 and 1850, the canal ceased operation in 1924 and has since become one of the nation's most unusual historic parks. In 1975-76, the C & O Canal encountered a unique problem with waste disposal.

Pit toilets had been used in the more frequently used areas along the canal. Concern developed that pit toilets might be contaminating the ground water, and in 1972 the C & O substituted portable toilets, to comply with environmental quality standards. Waste from the portable toilets was trucked to local municipal treatment plants. After three years, operators of the local plants informed park officials they would no longer accept the waste. Allegedly, the toilet chemicals were interfering with the biological processes of the waste treatment plants.

Alternatives suggested included closing the towpath, transporting the waste to municipalities outside the district, building a sophisticated treatment facility, and constructing an experimental composting system. The last option was selected, since NPS felt it could modify the USDA-Beltsville composting technology for use with these high liquid content wastes. A cooperative effort was begun between the maintenance staff of the Piedmont District of the C & O Canal and scientists of the Ecological Services Laboratory (ESL) in Washington, D.C.

Composting is a naturally occurring phenomenon that man has enhanced. Scientists at the Science and Education Administration, USDA, in Beltsville, MD, had developed an aerated static pile composting system, described in Vol. 48, No. 4, *Journal of Water Pollution Control Federation*, "A Force Aeration System for Composting Wastewater Sludge," by Epstein, Willson, Burge, Mullen and Enkiri. These techniques were developed and refined to treat filter cake sludge from sewage treatment plants. The filter cake is approximately 20 percent solid, 80 percent liquid, differing significantly from raw waste, which is only 2 to 3 percent solids.

In the Beltsville technology, one volume of filter cake sludge is thoroughly mixed with two volumes bulking material, generally wood chips. A static pile is built over corrugated polyethylene tubing and the air is drawn through the pile during composting. The "static pile" is monitored periodically to assure proper oxygen balance and adequate temperature buildup. After 21 days, the pile is dismantled and allowed to cure. The organic material produced is excellent soil conditioner and has value as a low analysis fertilizer.

The static pile technique was modified to include several additional bulking organic materials to absorb the excess liquid fraction. The technique has been perfected and has received favorable response from the C & O Canal staff and the NPS. By June 1976, waste material was being treated effectively by composting on a routine basis.

Waste generation and need for waste treatment has the same seasonal variation as visitation along the Canal. In general, the last static pile setup is in October or early November. This pile usually is allowed to stand until early spring. It is then dissassembled and a new static pile is built in April or May to compost the first wastes collected for the season. During heaviest visitation in the summer months, compost piles may be built every four to six weeks. Waste is pumped from the toilets as necessary during the season, then transferred to an on-site storage tank. When the tank nears its 2,000 gallon capacity, a compost pile can be built. The tank, though not essential, provides for more efficient use of both manpower and site activities.

To initiate composting, a bed of absorbent organic materials is prepared for receipt of the liquid waste from the holding tank. At the C & O, the absorbent organic mixture is comprised of shredded office waste paper, sawdust, wood chips, leaves, and previously composted material. These are thoroughly blended on a concrete mixing pad, then formed into a saucer-like configuration. Waste from the tank above the pad is gravity-fed into the saucer. Absorption (about 30 minutes) is followed with thorough mixing of waste and absorbent materials by a front-end loader.

Adjacent to the mixing pad is a mattress of previously composted materials, to receive the mixture of waste and absorbent materials. Details on how air is supplied and odors mitigated can be had from the ESL Lab.

The absorbent mixture of bulking materials and waste is transferred onto the mattress from the mixing pad, the completed pile resembling an inverted cone. A blanket of compost or wood chips insulates the pile to maintain necessary composting temperatures and suppresses odors produced during early stages of biologic action. An electrically operated blower draws air through the pile at intervals preselected on a timer.

Careful monitoring of the pile is essential. A range of 5 to 15 percent oxygen is optimum for microbial activity. Microbial activity generates heat to reach temperatures of 55° C (131° F) and above. The heat is produced as the microorganisms digest the nitrogen and carbon of the waste during aerobic metabolism. Temperatures should range between 60 and 70° C for a period of three weeks; this temperature usually is reached within the first 3 to 5 days of composting.

A minimum of 55° C for three days is necessary to kill pathogens. Temperatures as high as 80° C (176° F) sometimes are reached within the first 10 days. The compost pile will maintain very high temperatures for only a few days and will slowly decrease to about 60° C (150° F) for several weeks. High temperatures for prolonged periods result in a nearly sterile composted product.

The C & O composting site is less than one acre. This includes a pad (approximately 150' x 75'), a diversion ditch which surrounds the pad, and an organic storage area. The C & O Canal composts between 8,000 and 35,000 gal/year (33-145 tons/year). Designed to handle 105,000 gal/year, the site has not approached capacity. So far the operation has required no more than 0.2 work year for complete operation of all activities.

Success of the operation within the Piedmont District has sparked a similar operation in the Allegheny District of the C & O Canal. The design and site were prepared and implemented in 1979 and ac-

***A complete view** of the Piedmont District composting site at C & O Canal. Left to right are: shed housing the blower, a compost pile being constructed, a blanket of compost being added to the wet mixture to insulate against excessive heat loss, protect from rainfall and reduce odor. Behind the tractor is a working static compost pile. The storage tank with concrete mixing apron in front of it is at the extreme right. The slope around the site diverts runoff to a holding basin in the photo foreground.*

tive composting has taken place ever since.

Compost contains nominal amounts of essential soil nutrients, however these levels are generally low. Since compost has a nearly neutral pH, (about 6.6 to 6.8), it is an effective soil liming agent. The ESL has used compost to neutralize highly acidic spoil from Prince William Forest Park's pyrite mine, where the pH was as low as 2.0 to 2.4. It was felt that compost would be the principal soil amendment in restoring a favorable soil chemistry and provide a soil medium to support native vegetation.

Compost has proven a desirable amendment for soil renovation. Large quantities have been used in rebuilding soils and turf areas of the National Capital Region. The C & O Canal has used it in areas where culverts have been restored and vegetation reestablished around park facilities. A similar system is to be set up in Redwood NP, California, where it is proposed to treat wastes from sanitary toilets and septic systems and use the composted product to restore badly eroded slopes.

The methodology has received considerable attention from international organizations as a useful, cost effective, efficient way to treat wastes and at the same time produce a valuable, safe soil amendment. Demonstrations have been staged for representatives of the World Bank, AID, Appropriate Technology International, Inter-American Development Bank, Pan American Health Organization, EPA, USDA, USFS, USDI, and many other federal and state groups.

Composting has broad applicability throughout the entire National Park System. Small batch, raw waste composting is possible at back country campsites, using power from photovoltaic solar panels. Each location requires some modification of the system, depending on the kind, amount and availability of bulking materials. Proper ration of bulk to waste must be empirically established, as must the time required for adequate breakdown (treatment) of the mixture, the cycling frequency and size of the blower system, and the utilization of the compost product. Since absorbent materials could be limiting at some locations, it could be necessary to recycle cured compost to achieve desired consistency in static pile construction. Thickness and composition of the blanket, frequency of setup-teardown schedules, and availability of manpower and equipment to handle the waste materials also require site-specific solutions.

Additional references are Leonard and Fay's 1978 Forest Service Research Note (NE-254), "A Compost Bin for Handling Privy Wastes: Its Fabrication and Use," and Patterson and Short's 1980 paper on "Static Pile Composting of Sanitary Toilet Waste and Septage Within a National Park," from the *Proceedings* of the National Conference of Municipal and Industrial Sludge Composting-Materials Handling, sponsored by Information Transfer, Inc., Hazardous Materials Control Institution, the Sludge Magazine, and SEA-USDA, Nov. 14-16.

Patterson and Short are agronomists with the Ecological Services Laboratory, National Capital Region, NPS.

***Gravity flow** from an elevated storage tank allows for efficient emptying of the tank. The absorptive organic mixture of shredded waste paper, compost, wood chips, leaves and sawdust effectively absorbs the liquid waste. Absorption will proceed for about 30 minutes.*

***Perforated piping** and the mattress are in place at the right, while the solid (non-perforated) piping connects perforated piping of the pile.*

Resource Information Tracking System (RITS) Software Started

By Ro Wauer

Inadequate information is an extremely serious obstacle to sound planning and decision-making. It is even more serious when the protection of a nationally significant resource depends upon that information. And it is a gross malfeasance when significant information is available but can not be retrieved when necessary.

The demand for available information far exceeds the present capability of the National Park Service to provide it. This shortcoming affects every facet of management in the parks, regions and the central office. It leads to delays, redundancies in efforts and costs, increased paperwork, and errors that directly affect the very resources the Service is mandated to preserve.

Although the Service has initiated many well-conceived data-gathering projects, ranging from inventories to long-term environmental monitoring, the majority last only as long as the principal investigator remains on site; the products from these endeavors often are utilized only so long as the users know where to find readily the necessary information. Important and worthwhile information is often lost or forgotten because of its inaccessibility.

This problem of inadequate information flow was identified in the 1981 *State of the Parks Prevention/ Mitigation Report,* a followup to the initial *State of the Parks – 1980 Report to Congress.* The Prevention/ Mitigation Report outlined a strategy for threat identification, assessment, monitoring, and prevention and mitigation. This systematic approach begins with comprehensive Resources Management Plans (RMPs) required for every park unit. Each Plan must include a series of Project Statements that document all of a park's resource projects; they range in detail and importance from such housekeeping activities as vista-clearing or hazardous tree control to more serious problems of internal and external impacts to park values. The framework outlined in the Prevention/ Mitigation Report encompasses an information management system, built upon the numerous Project Statements, and capable of tracking those activities throughout their existence, including all resultant reports. This information management system is RITS, A Resource Information Tracking System.

R I T S will serve three major functions:

1) It will track all ongoing and proposed NPS resources management activities that have been classified as either resources management, monitoring, or research and documented within area RMPs;

2) It will incorporate a process for putting in new and pertinent information at the regional level and at some park areas as the information becomes available; and

3) It will provide storage and instant retrieval of information about management, monitoring and research within each park unit and throughout the service. Key words will be utilized for information retrieval.

R I T S will consist of three subsystems:

1) natural and cultural resources management data derived from the park's RMPs as described above;

2) abstracts of all reports derived from monitoring and research projects described in Project Statements, as well as from other closely related reports from a variety of sources; and

3) resource activities that are approved through special use permits issued by park personnel for studies and other resources management activities. These Resource Activity Permits include research and monitoring undertaken by non-NPS scientists or resource managers, and will replace the Superintendent's Annual Research Report. The Resource Activity Permit subsystem will provide the system with the most up-to-date information available from the parks.

The first step in the evolution of R I T S software is underway. A functional requirements document is being written and will provide information about details of the system sufficient for actual design to begin by late summer or early fall.

Also underway is a complete review of area RMPs to determine compliance with the guidelines. Some clarification of the guidelines will be required to assure Plan consistency to the degree that they can be utilized as the basis for R I T S.

It is anticipated that R I T S will be a reality by 1984. It is expected to function on either IBM or HP hardware; that decision will be made by late summer, 1982. The Washington Office plans to develop and maintain the system; users at the parks and regions will be charged for system use on a time basis.

Taken together, records of the various activities will constitute a significant information base. R I T S will:

– document the resources management, monitoring and research activities (as outlined in area RMPs) through all stages of conception, implementation and project reporting;

– provide reference on state-of-the-art methods and techniques for accomplishing (1) resources management tasks, (2) monitoring tasks, and (3) research tasks.

Because area RMPs will provide the basis for R I T S development, it is especially important that the Plans, which are the responsibility of park superintendents, be as complete and concise as possible. Consistency is of greatest importance!

R I T S will provide Service personnel instantaneously with up-to-date information and tie together the functions of resources management planning, management, monitoring, research, and reporting into a cohesive and integrated program. It will help to move the Service into a more modern mode to cope with the resource threats of our modern technological society.

Wauer is chief, NPS Natural Resource Management Division, Washington, D.C.

The Greenhouse Effect Attracts Speculation

The January issue of *Agroborealis,* published by the University of Alaska Agricultural Experiment Station, Fairbanks, AK 99701, carries an article by Glenn Juday, a visiting associate professor and ecological reserves coordinator, titled "Climatic Trends in the Interior of Alaska: Moving Toward a High CO_2 World?" Juday's analysis begins with the peak of the last glacial period, about 14,000 years ago, and notes that the change from full glacial to modern climate conditions "was very rapid in northwestern North America, being essentially completed in 1,000 years." He traces the forest-tundra treeline in the central Canadian Arctic as a shifting climate marker readable in terms of the past several thousand years, and adds to that record the ground and soil temperatures "since the ground 'remembers' the temperature to which it has been exposed by storing the heat (or cold, depending upon your point of reference.)"

Juday concludes that "perhaps the most far-reaching consequences of CO_2 induced climatic warming would come about if the hypothesized collapse of the west Antarctic ice shelf occurred, rapidly raising world ocean levels by nearly 16.5 feet (Mercer, J.H. 1978. West Antarctic ice sheet and the CO_2 greenhouse effect: a threat of disaster. *Nature* 271:321)." On the other hand, he points out, although much of western and northern Alaska's coastal region would be inundated, a real warming could enhance the prospects for success of Alaska's new agricultural development projects.

An article ("Computing Climate,") in the May issue of *Science 82* on long-range climate modeling with computers, suggested that the chances for accuracy from such forecasts were "0 to 100%." A letter to the editor of *Science 82* in the July-August issue disagrees on the basis of a National Academy of Science panel (in 1979) that tried, with no success, to find a factor that would diminish to negligible proportions the effects of a carbon dioxide rise. The panel concluded that a global temperature rise of between two and five degrees Celsius was likely.

PARK SCIENCE

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